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ROBOTICS & AI

Including Case Based Questions

CLASS 10

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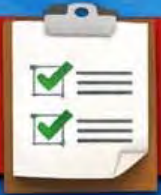
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CONTENTS

	ICSE Examination Paper 2026	5-12
CHAP 1.	New Age Robotic Systems	13-37
CHAP 2.	From Robots to Cobots	38-60
CHAP 3.	Components of Robots as a System	61-82
CHAP 4.	Visualization, Design and Creation of Components	83-103
CHAP 5.	Integrating Robots as a System	104-127
CHAP 6.	Decision Making in Machines and Computers	128-149
CHAP 7.	Machine Intelligence and Cyber Security in Computing	150-170
CHAP 8.	Components of AI Project Framework	171-191
CHAP 9.	Modules and Packages in Python	192-214
CHAP 10.	Lists and Tuples in Python	215-234
CHAP 11.	Strings in Python	235-256

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ICSE Class X Examination Paper 2026
ROBOTICS AND ARTIFICIAL INTELLIGENCE

Time: 2 Hours

Max. Marks: 100

General Instructions:

1. Answer to this Paper must be written on the paper provided separately.
2. You will not be allowed to write during first 15 minutes.
3. This time is to be spent in reading the question paper.
4. The time given at the head of this Paper is the time allowed for writing the answers.
5. Attempt all questions from Section A and any four questions from Section B.
6. The intended marks for questions or parts of questions are given in brackets [].

SECTION-A (40 Marks)

(Attempt all questions from this Section.)

QUESTION 1.

Choose the correct answers to the questions from the given options.

(Do not copy the questions, write only the correct answers.)

- (i) Study the image given below.



In which field is this robot used?

- (a) Defence
- (b) Agriculture
- (c) Medicine
- (d) Entertainment

Ans :

- (b) Agriculture

The image shows robots working in a farm field and collecting crops in baskets. This type of robot is used for farming activities such as harvesting, planting, and

monitoring crops. Therefore, the robot is used in the field of Agriculture.

- (ii) _____ is an example of deterministic computing.

- (a) Traffic light sequencing
- (b) Autonomous driving
- (c) Stock market prediction
- (d) Face recognition

Ans :

- (a) Traffic light sequencing

Deterministic computing means the output is fixed and predictable for a given input. Traffic light sequencing follows a predefined order (Red → Yellow → Green) based on set timing rules. Since the output is predictable and rule-based, it is an example of deterministic computing.

- (iii) A room heater is an example of a/an:

- (a) gear
- (b) robot
- (c) actuator
- (d) machine

Ans :

- (d) machine

A machine is a device that uses energy to perform a specific task. A room heater converts electrical energy into heat energy to warm a room. It does not act as a robot or actuator, and it is not a gear. Therefore, a room heater is a machine.

- (iv) Tinkercad is commonly used for:

- (a) simulating robotic movements
- (b) data encryption
- (c) performing gear ratio calculations only
- (d) building operating systems

Ans :

- (a) simulating robotic movements

Tinkercad is an online platform used for designing, simulating, and testing electronic circuits and basic robotic systems. It allows users to simulate components like Arduino and motors. Hence, it is commonly used for simulating robotic movements.

- (v) In the block diagram of a robotic control system, the correct sequence is:

- (a) Input → Robot → Controller → Feedback
- (b) Feedback → Input → Controller → Robot
- (c) Input → Controller → Robot → Feedback
- (d) Controller → Input → Robot → Feedback

Ans :

- (c) Input → Controller → Robot → Feedback

In a robotic control system:

1. Input is given through sensors or user commands.
2. The Controller processes the input.
3. The Robot (Actuator) performs the action.
4. Feedback is sent back to monitor and adjust the system.

Thus, the correct sequence is

Input → Controller → Robot → Feedback.

- (vi) Which of the following is an example of a linear actuator?

- (a) DC motor
- (b) Pneumatic piston
- (c) Arduino
- (d) Electric fan

Ans :

- (b) Pneumatic piston

A linear actuator produces motion in a straight line. A pneumatic piston moves back and forth in a straight path using air pressure, making it a linear actuator. A DC motor and electric fan produce rotational motion, and Arduino is a microcontroller, not an actuator.

- (vii) From the following, which function of Python checks whether all characters in a string 's' are alphanumeric?

- (a) `s.allnum()`
- (b) `s.isnumal()`
- (c) `s.isalnum()`
- (d) `s.isalphanum()`

Ans :

- (c) `s.isalnum()`

In Python, the function `isalnum()` checks whether all characters in a string are alphanumeric (i.e., letters and numbers) and returns True or False. The other options are not valid Python string methods. Hence, the correct answer is `s.isalnum()`.

- (viii) A motor drives a small gear with 10 teeth which is connected to a larger gear with 40 teeth. What is the gear ratio?

- (a) 4 : 1
- (b) 1 : 4
- (c) 1 : 2
- (d) 2 : 1

Ans :

- (a) 4 : 1

Gear ratio is calculated as:

Gear Ratio = Number of teeth on larger gear \ Number of teeth on smaller gear

$$= 40 : 10$$

$$= 4 : 1$$

Therefore, the gear ratio is 4 : 1.

- (ix) Which of the following string operators in Python is used to find the length of a string 'a'?

- (a) `len(a)`
- (b) `len()`
- (c) `a.len()`
- (d) `a.len(a)`

Ans :

- (a) `len(a)`

In Python, the built-in function `len()` is used to find the length of a string. When applied to string 'a', it is written as `len(a)`. The other options are incorrect syntax.

- (x) Unauthorised hardware access leads to:

- (a) loss of data
- (b) increased computer speed
- (c) better performance
- (d) having more data

Ans :

- (a) loss of data

Unauthorised hardware access can result in damage, data theft, or deletion of important information. It creates security risks and may cause loss of data. It does not improve performance or increase speed.

- (xi) In machine learning, testing data is primarily used to:

- (a) train the model for better performance.
- (b) measure model performance on unseen data.
- (c) store training parameters.
- (d) provide labels for training.

Ans :

- (b) measure model performance on unseen data.

In machine learning, data is divided into training data and testing data. The training data is used to train the model, while the testing data is used to evaluate how well the

model performs on new, unseen data. Therefore, testing data is used to measure model performance.

- (xii) The function of a sensor is to:
- detect changes in environment and send signals.
 - process the input data and make decisions.
 - change electrical energy into motion.
 - supply power to the robot.

Ans :

(a) detect changes in environment and send signals.
A sensor detects physical changes such as light, temperature, pressure, or motion in the environment and converts them into electrical signals. These signals are sent to the controller for processing. It does not make decisions, supply power, or create motion.

- (xiii) The purpose of Turing Test is to evaluate:
- memory consumption of a computer.
 - the processing speed of computers and humans.
 - two computer programs.
 - if a machine can exhibit human-like responses.

Ans :

(d) if a machine can exhibit human-like responses.
The Turing Test, proposed by Alan Turing, is used to determine whether a machine can imitate human intelligence in conversation. If a machine can respond in a way that is indistinguishable from a human, it is said to have passed the test.

- (xiv) _____ software is used to simulate a robotic system.
- Libre Office
 - MS Word
 - Tinkercad
 - MySQL

Ans :

(c) Tinkercad
Tinkercad is a simulation software used to design and test circuits and robotic systems virtually. Libre Office and MS Word are word-processing tools, and MySQL is a database management system. Therefore, the correct answer is Tinkercad.

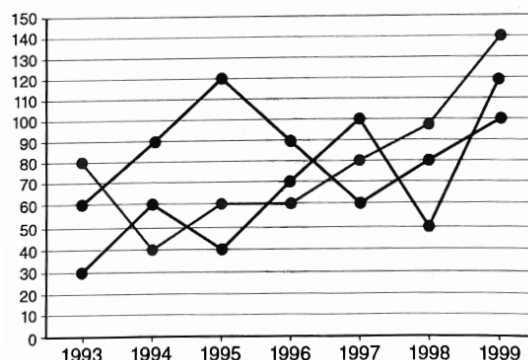
- (xv) **Assertion (A) :** Robots use actuators for movement.
Reason (R) : Actuators sense the environments and convert it to electrical signals.
- (A) is true but (R) is false.
 - (A) is false but (R) is true.
 - Both (A) and (R) are true and (R) is the correct explanation for (A).
 - Both (A) and (R) are true but (R) is not the correct explanation for (A).

Ans :

- (a) (A) is true but (R) is false.

Robots use actuators such as motors and hydraulic systems to produce movement, so the assertion is true. However, sensing the environment and converting it into electrical signals is the function of sensors, not actuators. Actuators convert electrical energy into physical motion, making the reason incorrect.

- (xvi) Identify the type of graph shown below :



- Scatter plot
- Bar graph
- Pie chart
- Line graph

Ans :

(d) Line graph
The graph shows data points for different years connected by straight lines. This indicates changes and trends over time. Since the values are plotted and joined to display continuous variation, it is a line graph, not a bar graph, scatter plot, or pie chart.

- (xvii) In AI problem scoping, "Who" refers to the:

- dataset used for training.
- end users affected by the project.
- programming environment used.
- hardware requirements of the project.

Ans :

(b) end users affected by the project.
In AI problem scoping, the "Who" identifies the stakeholders or end users who will use or be affected by the AI solution. It focuses on understanding the target audience and beneficiaries of the project.

- (xviii) Give the output of the following Python code:

```
msg = "Artificial Intelligence"
print(msg[11:14])
```

- tel
- Int
- ell
- gen

Ans :

(b) Int

In Python, string indexing starts from 0.

“Artificial Intelligence”

Index positions:

A(0) r(1) t(2) i(3) f(4) i(5) c(6) i(7) a(8) l(9) (10) I(11)
n(12) t(13) e(14)...

The slice `msg[11:14]` extracts characters from index 11 to 13 (14 is excluded).

So, it returns “Int”.

(xix) The keyword used to include a package or module in a Python program is:

- (a) export
- (b) include
- (c) collect
- (d) import

Ans :

(d) import

In Python, the keyword import is used to include a module or package into a program so that its functions and features can be used.

(xx) What will be the output of the Python code given below?

```
x = "BOARD EXAMINATION"
print(x[0:4:2])
```

- (a) BOAR
- (b) BA
- (c) OR
- (d) Error

Ans :

(b) BA

The slicing format is:

`string[start : stop : step]`

Here,

Start = 0

Stop = 4

Step = 2

Characters at positions:

0 → B

2 → A

So the output will be “BA”.

QUESTION 2.

Answer the following questions :

(i) Mention any two sensors used in autonomous drones.

Ans :

Two sensors used in autonomous drones are:

- 1. GPS Sensor
- 2. Ultrasonic Sensor

(ii) ‘In a hospital, cobots assist nurses in delivering medicines to patients.’

Give any two advantages of using cobots in hospitals.

Ans :

- 1. Cobots reduce the workload of nurses.
- 2. Cobots increase efficiency and accuracy in delivering medicines.

(iii) What is spur gear? Mention one application of spur gear in robotics.

Ans :

A spur gear is a cylindrical gear with straight teeth that transmits motion between parallel shafts.

Application: Spur gears are used in robotic arms to control speed and torque.

(iv) Explain the role of data in Machine Learning.

Ans :

Data is the foundation of Machine Learning. It is used to train the model so that it can learn patterns and make predictions. The quality and quantity of data directly affect the accuracy and performance of the model.

(v) How is machine intelligence similar to human intelligence?

Ans :

Machine intelligence is similar to human intelligence because both can:

- 1. Learn from experience or data.
- 2. Make decisions based on information.

Machines imitate human thinking processes using algorithms.

(vi) Mention any one benefit of using Kaggle for data acquisition.

Ans :

One benefit of using Kaggle is that it provides free access to large, real-world datasets for practice and model training.

(vii) Why is modelling important in AI project frame work?

Ans :

Modelling is important because it helps create and train the AI system using selected algorithms. It allows the system to learn patterns from data and make accurate predictions or decisions.

(viii) What will be the output of the following Python code?

```
a = 5
b = 3
print(a > b and b < 3)
```

Ans :

False

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- (ix) What will be the output of the following Python code?
- ```
str1 = 'PYTHON'
print(str1[1:4])
```

**Ans :**

YTH

Index positions:

P(0) Y(1) T(2) H(3) O(4) N(5)

Slice [1:4] means index 1 to 3.

So, the output is YTH.

- (x) What will be the output of the following Python code?
- ```
s = "Great Day"
print(s.count('a'))
print(s.startswith('g'))
```

Ans :

False

The letter 'a' appears once in "Great Day".

startswith('g') checks for lowercase 'g'. Since the string starts with uppercase 'G', it returns False.

SECTION-B (60 Marks)

(Answer any four questions from this section.)

The answers in this section should consist of the programs in either Python environment or any program environment with Python as the base.

Each program should be written using variable description/mnemonic codes so that the logic of the program is clearly depicted.

Flowcharts and algorithms are not required.

QUESTION 3.

- (i) What are Assistant Robots?

Ans :

Assistant Robots are robots designed to help humans in performing daily tasks. They support users by providing services such as cleaning, delivering items, guiding people, or assisting in healthcare. These robots work alongside humans to make tasks easier, safer, and more efficient. Examples include hospital delivery robots and home assistant robots.

- (ii) Give any two differences between deterministic computing and probabilistic computing with an example.

Ans :

Basis	Deterministic Computing	Probabilistic Computing
Nature of Output	Produces the same output for a given input every time.	May produce different outputs for the same input due to randomness or probability.
Handling of Uncertainty	Does not handle uncertainty; results are exact and fixed.	Handles uncertainty using probability values and likelihoods.
Example	Calculator performing $2 + 3 = 5$.	Weather forecasting with 70% chance of rain.

- (iii) A company XYZ Ltd. records its monthly sales in lakhs as follows:

Month = ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun']

Sales = [25, 30, 28, 35, 40, 38]

Write a Python program using Matplotlib to:

- Store the data.
- Plot a bar chart with month on X-axis and sales on Y-axis.
- Label the axes and give a title "XYZ Ltd. Half-Yearly Sales".

Ans :

```
# Importing matplotlib library
import matplotlib.pyplot as plt
# Storing the data
month = ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun']
sales = [25, 30, 28, 35, 40, 38]
# Plotting the bar chart
plt.bar(month, sales)
# Labelling the axes
plt.xlabel("Month")
plt.ylabel("Sales (in Lakhs)")
# Giving title
plt.title("XYZ Ltd. Half-Yearly Sales")
# Displaying the chart
plt.show()
```

```

### QUESTION 4.

- (i) What are smart homes? Name any two features that make a home a smart home.

**Ans :**

A smart home is a home equipped with internet-connected devices that can be controlled remotely to manage appliances and systems such as lighting, security, and temperature. Two features of a smart home:

1. Automated lighting and temperature control.
2. Smart security systems with cameras and remote monitoring.

- (ii) Briefly explain Data Exploration from AI project framework.

**Ans :**

Data Exploration is the stage in the AI Project Framework where the collected data is analyzed to understand its structure, patterns, and relationships.

It involves:

1. Checking data quality
2. Identifying missing values
3. Finding trends and patterns

This step helps in selecting the right model and improving accuracy.

- (iii) Write a Python program to plot a pie chart comparing marks of five students as given below:

```
Student name = ['Jessica', 'Peter',
 'Alexa', 'James', 'Ram']
Marks = [48, 22, 14, 30, 49]
Import the necessary libraries.
```

**Ans :**

```
``python
Importing necessary library
import matplotlib.pyplot as plt

Storing the data
students = ['Jessica', 'Peter',
 'Alexa', 'James', 'Ram']
marks = [48, 22, 14, 30, 49]

Plotting the pie chart
plt.pie(marks, labels=students,
 autopct='%1.1f%%')
Adding title
plt.title("Marks Distribution of
Five Students")
Displaying the chart
plt.show()
```

### QUESTION 5.

- (i) Name the type of sensor used for each of the following purposes:
- (a) Detecting obstacles
  - (b) Measuring light intensity
  - (c) Measuring temperature

**Ans :**

- (a) Ultrasonic Sensor
- (b) Light Sensor (LDR)
- (c) Temperature Sensor

- (ii) Explain software theft. Mention any two consequences of software theft.

**Ans :**

Software theft refers to the illegal copying, downloading, sharing, or using of software without proper permission or license from the owner. It is also known as software piracy. Two consequences of software theft:

1. Legal action or penalties.
2. Financial loss to the software company.

- (iii) Write a Python program to do the following tasks:

1. Input a sentence and store it to a string variable.
2. Print the length of the string, its first character, and its last character.
3. Use a loop to traverse through the string and print the total number of digits present.

**Ans :**

```
python
Input a sentence
sentence = input("Enter a sentence:
")
Printing length, first and last
character
print("Length of string:",
len(sentence))
print("First character:",
sentence[0])
print("Last character:",
sentence[-1])
Counting digits
digit_count = 0
for ch in sentence:
 if ch.isdigit():
 digit_count += 1
print("Total number of digits:",
digit_count)
```

### QUESTION 6.

- (i) Briefly describe the different types of joints in robotics.

**Ans :**

1. Revolute Joint : This joint allows rotational movement around a fixed axis, similar to a door hinge. It is commonly used in robotic arms..

2. **Prismatic Joint :** This joint allows linear (straight-line) movement along one axis. It is used when a robot part needs to slide forward or backward..
3. **Spherical Joint :** This joint allows movement in multiple directions, similar to a ball-and-socket joint in the human shoulder. It provides greater flexibility.

(ii) What is data theft? Give any two causes of data theft.

**Ans :**

Data theft is the unauthorized copying or stealing of confidential or sensitive information from a computer or network.

Two causes of data theft:

1. Weak passwords or poor security measures.
2. Malware or phishing attacks.

(iii) Write a Python program to:

1. Create a list of 10 numbers.
2. Print the elements in the 2nd and 4th index of the list.
3. Sort the list in ascending order.
4. Ask the user to enter a number and search whether it exists in the list or not.

**Ans :**

```
```python
# Creating a list of 10 numbers
numbers = [45, 12, 78, 34, 23, 89, 10, 67, 56, 90]
# Printing elements at 2nd and 4th index
print("Element at 2nd index:", numbers[2])
print("Element at 4th index:", numbers[4])
# Sorting the list in ascending order
numbers.sort()
print("List after sorting:", numbers)
# Searching for a number
num = int(input("Enter a number to search: "))

if num in numbers:
    print("Number exists in the list.")
else:
    print("Number does not exist in the list.")
```
```

## QUESTION 7.

(i) Explain the role of controllers in a robotic system. How do they work together with sensors and actuators?

**Ans :**

A controller is the brain of a robotic system. It processes the input received from sensors and sends appropriate signals to actuators.

Working process:

1. Sensors detect changes in the environment and send signals to the controller.
2. The controller processes the information and makes decisions.
3. Actuators receive instructions from the controller and perform the required action.

Thus, sensors, controllers, and actuators work together in a loop to perform tasks efficiently.

(ii) Briefly explain supervised learning.

**Ans :**

Supervised learning is a type of machine learning in which the model is trained using labelled data.

In this method:

1. Input data is provided along with correct output labels.
2. The model learns patterns from the training data.
3. It then predicts outputs for new unseen data.

Example: Email spam detection.

(iii) Write a Python program that performs the following tasks on a tuple:

1. Create a tuple with elements (12, 27, 30, 47, 55, 49)
2. Convert tuple into list.
3. Remove element 30 from the list.
4. Append a new list with elements [5, 25]
5. Insert element 11 at index 3.
6. Print the list.
7. Convert the list to a tuple.

**Ans :**

```
```python
# Creating a tuple
t = (12, 27, 30, 47, 55, 49)
# Converting tuple to list
lst = list(t)

# Removing element 30
lst.remove(30)

# Appending a new list
lst.append([5, 25])

# Inserting element 11 at index 3
```

```
lst.insert(3, 11)

# Printing the list
print("Modified List:", lst)

# Converting list back to tuple
new_tuple = tuple(lst)
print("Converted Tuple:", new_tuple)
```

```

**QUESTION 8.**

- (i) What is Tinkercad? Give any two features of the Tinkercad workspace.

**Ans :**

Tinkercad is an online web-based application used for designing 3D models, simulating electronic circuits, and coding Arduino projects.

Any two features of Tinkercad workspace:

1. Circuit simulation with virtual components like Arduino, LEDs, and sensors.
2. 3D design tools for creating and modifying objects.

- (ii) Give any three different ways to represent data to gather meaningful information.

**Ans :**

The following table shows three different ways to represent data to gather meaningful information:

| Method of Data Representation | Description                                                     |
|-------------------------------|-----------------------------------------------------------------|
| Bar Chart                     | Used to compare quantities across different categories.         |
| Pie Chart                     | Used to show proportions or percentage distribution of a whole. |
| Line Graph                    | Used to display trends or changes in data over a period of time |

- (iii) Write a Python program that performs the following operations on a string:

1. Define a string with the value "Machine Learning".
2. Convert the string to lowercase and print it.
3. Replace the word "Machine" with "Deep".
4. Check if the string ends with "Learning" and print the result (True/False).
5. Count and print the number of occurrences of the letter "n".

**Ans :**

```
python
Defining the string
s = "Machine Learning"
```

**NODIA**

```
Convert to lowercase
lower_s = s.lower()
print("Lowercase string:", lower_s)
Replace "Machine" with "Deep"
replaced_s = s.replace("Machine", "Deep")
print("After replacement:", replaced_s)
Check if string ends with "Learning"
print("Ends with 'Learning':", s.endswith("Learning"))
Count occurrences of letter 'n'
count_n = s.count('n')
print("Number of occurrences of 'n':", count_n).
```

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# CHAPTER 1

## NEW AGE ROBOTIC SYSTEMS

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### SUMMARY

#### 1. INTRODUCTION TO ROBOTICS AND AI

Robotics involves designing, constructing, and operating robots—machines that can perform tasks automatically or with minimal human intervention.

AI enables machines to mimic human intelligence by learning from data, making decisions, and solving problems.

Modern robotic systems often integrate AI to process sensor data, adapt to their environments, and improve their functionality.

#### 2. APPLICATIONS OF ROBOTICS AND AI

##### 2.1 Warehouse Robots

Automate tasks like sorting, packing, transporting, and inventory management in large warehouses.

Examples :

**Amazon's Kiva Robots :** These robots navigate warehouse floors to retrieve and deliver items.

**Advantages :**

1. Increased efficiency and speed in handling goods.
2. Reduction in human error.
3. Enhanced safety in potentially hazardous environments.

##### 2.2 Assistant Robots

Designed to aid humans in everyday tasks, from household chores to specialized support.

Examples :

**Personal Assistant Robots :** Such as robotic vacuum cleaners (e.g., Roomba) that autonomously clean floors.

**Healthcare Assistants :** Robots that help elderly or disabled individuals by performing routine tasks or providing companionship.

**Advantages :**

1. Improved quality of life.
2. Assistance in environments where human labor is limited or requires augmentation.

##### 2.3 Smart Homes

Use integrated devices and sensors to create a connected environment that enhances convenience, security, and energy efficiency.

Examples :

1. Automated lighting and heating systems.
2. AI-powered security systems (e.g., facial recognition at entry points).

**Advantages :**

1. Remote monitoring and control.
2. Energy savings and increased safety.

##### 2.4 Smart Schools

Enhance the learning environment through technology integration.

Examples :

1. Interactive smart boards.
2. AI-driven teaching assistants and personalized learning platforms.

**Advantages :**

1. Improved engagement and personalized education.
2. Efficient management of school resources and schedules.

##### 2.5 Smart Mobility

Revolutionize transportation by integrating technology for efficient traffic management and vehicle control.

Examples :

1. AI-based traffic management systems.
2. Connected vehicles that communicate with each other and infrastructure.

**Advantages :**

1. Reduced congestion.
2. Enhanced safety and lower emissions.

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## 2.6 Autonomous Cars / Driver Assisted Cars

1. Autonomous Cars : Vehicles that navigate without human intervention by using sensors, cameras, and advanced algorithms.
2. Driver Assisted Cars : Vehicles with features like adaptive cruise control, lane-keeping assist, and automatic braking.

Examples : Self-driving car prototypes from companies like Tesla, Waymo, etc.

### Advantages :

1. Increased road safety.
2. Reduced traffic accidents.
3. Enhanced mobility for those unable to drive.

## 2.7 Autonomous Drones

Unmanned aerial vehicles that operate independently using AI for navigation and task execution.

Examples :

1. Drones used for package delivery (e.g., Amazon Prime Air).
2. Drones in agriculture for crop monitoring.
3. Surveillance and aerial photography drones.

### Advantages :

1. Access to remote or hazardous areas.
2. Cost-effective and efficient monitoring solutions.

## 2.8 Robotics for Medicine and Healthcare

Apply robotic technology to improve medical procedures, rehabilitation, and patient care.

Examples :

1. Surgical Robots : Such as the da Vinci Surgical System that assists in minimally invasive surgeries.
2. Rehabilitation Robots : Devices that help patients regain movement after injuries.
3. Robotic Prosthetics : Advanced prosthetic limbs that mimic natural movement.
4. Telepresence Robots : Allow doctors to interact with patients remotely.

### Advantages :

1. Increased precision and reduced recovery times.
2. Enhanced access to specialized care.
3. Improved outcomes in surgeries and therapy.

## 2.9 Other Examples of Robotic Systems

### Elevators :

1. Overview : Elevators are everyday examples of robotic systems using automated control systems to operate reliably.

2. Function : Incorporate sensors, control algorithms, and safety mechanisms to move efficiently between floors.

### Additional Examples :

1. Robotic Arms in Manufacturing : For assembling products or handling dangerous materials.
2. Robotic Waiters or Service Robots : Employed in restaurants and hotels to deliver food or handle customer service tasks.

### Significance :

Demonstrates that robotics is not limited to high-tech laboratories but is integrated into daily life for enhanced convenience and safety.

## 3. NARS : NON-AXIOMATIC REASONING SYSTEMS

### 3.1 What is NARS?

NARS stands for Non-Axiomatic Reasoning System. It is a type of AI framework designed to operate under conditions of insufficient knowledge and limited computational resources.

### Key Concept :

Unlike traditional AI systems that rely on fixed, axiomatic rules, NARS is built to handle uncertainty and incomplete information—making it adaptable to real-world situations.

### 3.2 Why NARS are Relevant and Possible

#### Adaptability :

Real-World Environments : In everyday applications like smart homes or autonomous vehicles, conditions are unpredictable. NARS can adjust its reasoning as new data comes in.

#### Efficiency :

Limited Resources : NARS is optimized to work with the computational constraints typical in many robotic systems, making it practical for embedded systems.

#### Learning Capability :

Experience-Based Learning : NARS allows robots to improve their performance over time by learning from experience rather than relying on pre-programmed axioms.

#### Practicality :

Integration : As robotic systems become more complex and are required to make decisions in uncertain environments, the non-axiomatic approach provides a robust solution.

### 3.3 NARS in Robotic Systems

#### Decision Making :

Example in Smart Homes : A home assistant robot using NARS can make real-time decisions when encountering unexpected obstacles or changing household dynamics.

#### Error Handling :

Robustness : In applications like autonomous cars, NARS can help manage situations where sensor data is incomplete or conflicting, thus maintaining safe operation.

#### Future Applications :

Expansion : With the rise of IoT (Internet of Things) and increased inter connectivity, the adaptability of NARS makes it a promising approach for the next generation of intelligent robotic systems.

## MULTIPLE CHOICE QUESTION

- Which robotic system is designed to assist with household chores by autonomously cleaning floors?
  - Warehouse Robots
  - Personal Assistant Robots
  - Autonomous Drones
  - Robotic Arms in Manufacturing

Ans :

MAIN 2025

- Personal Assistant Robots

Personal Assistant Robots, such as robotic vacuum cleaners like Roomba, autonomously clean floors and perform other domestic tasks. They use AI and sensor data to navigate obstacles, adapt to room layouts, and enhance cleaning efficiency, thereby reducing manual labor and improving home convenience.

- Which robotic system automates tasks like sorting, packing, and transporting goods in large warehouses?
  - Smart Homes
  - Assistant Robots
  - Warehouse Robots
  - Autonomous Drones

Ans :

SQP 2021

- Warehouse Robots

Warehouse Robots, like Amazon's Kiva Robots, automate logistics by sorting, packing, and

transporting items. Their integration of AI and automated navigation increases operational efficiency, reduces human error, and enhances safety, transforming warehouse management into a more streamlined and productive process.

- Which system employs integrated devices and sensors to enhance convenience, security, and energy efficiency in residences?
  - Smart Schools
  - Smart Homes
  - Autonomous Cars
  - Healthcare Assistants

Ans :

COMP 2023

- Smart Homes

Smart Homes incorporate AI-powered devices, sensors, and automated control systems to manage lighting, heating, and security. This setup allows remote monitoring and control, leads to energy savings, and improves overall safety by using features like facial recognition and automated alerts for a connected living environment.

- Which technological application enhances learning environments through interactive smart boards and personalized teaching platforms?
  - Smart Mobility
  - Warehouse Robots
  - Smart Schools
  - Autonomous Drones

Ans :

MAIN 2024

- Smart Schools

Smart Schools integrate technologies such as interactive smart boards and AI-driven teaching assistants to create engaging, personalized learning experiences. This approach improves student participation, tailors education to individual needs, and optimizes resource management, thereby elevating the overall quality of modern education.

- Which robotic system revolutionizes transportation by integrating AI-based traffic management and vehicle communication systems?
  - Warehouse Robots
  - Smart Mobility
  - Elevators
  - Telepresence Robots

Ans :

SQP 2013

- Smart Mobility

Smart Mobility leverages AI to manage traffic flow and enable communication between vehicles and

infrastructure. This system reduces congestion, improves road safety, and lowers emissions by optimizing routes and vehicle interactions, ultimately transforming urban transportation into a more efficient and sustainable network.

6. Which type of vehicle navigates without human intervention using sensors, cameras, and advanced algorithms?

- (a) Autonomous Cars
- (b) Driver Assisted Cars
- (c) Warehouse Robots
- (d) Personal Assistant Robots

Ans :

COMP 2016

- (a) Autonomous Cars

Autonomous Cars use a combination of sensors, cameras, and sophisticated algorithms to navigate independently without human input. This self-driving technology enhances road safety by reducing human error, increases mobility for non-drivers, and represents a significant advancement in the integration of AI with transportation systems.

7. Which system features adaptive cruise control, lane-keeping assist, and automatic braking to enhance driving safety while still requiring human oversight?

- (a) Autonomous Cars
- (b) Driver Assisted Cars
- (c) Warehouse Robots
- (d) Robotic Waiters

Ans :

MAIN 2015

- (b) Driver Assisted Cars

Driver Assisted Cars are equipped with features like adaptive cruise control, lane-keeping assist, and automatic braking. These AI-powered systems provide real-time support to drivers, reducing workload and mitigating risks on the road while still maintaining human control, thereby significantly improving overall driving safety.

8. Which robotic system operates as unmanned aerial vehicles for applications like package delivery and crop monitoring?

- (a) Autonomous Drones
- (b) Personal Assistant Robots
- (c) Telepresence Robots
- (d) Rehabilitation Robots

Ans :

SQP 2019

- (a) Autonomous Drones

Autonomous Drones are unmanned aerial vehicles that use AI-driven navigation for diverse applications such as package delivery, agricultural monitoring, and surveillance. Their ability to access remote or hazardous areas, coupled with efficient data collection, makes them indispensable in scenarios where traditional methods might be inefficient or unsafe.

9. Which robotic system is utilized in healthcare to perform minimally invasive surgeries with enhanced precision?

- (a) Rehabilitation Robots
- (b) Surgical Robots
- (c) Telepresence Robots
- (d) Assistant Robots

Ans :

COMP 2006

- (b) Surgical Robots

Surgical Robots, like the da Vinci Surgical System, assist in performing minimally invasive surgeries with high precision. Their integration of robotics and AI allows for smaller incisions, reduced recovery times, and improved surgical accuracy, thereby advancing modern medical procedures and patient outcomes.

10. Which system aids patients in regaining movement and strength after injuries through guided physical therapy?

- (a) Warehouse Robots
- (b) Rehabilitation Robots
- (c) Personal Assistant Robots
- (d) Autonomous Cars

Ans :

MAIN 2012

- (b) Rehabilitation Robots

Rehabilitation Robots support patients during physical therapy by providing consistent, guided movements and exercises. Their use in clinical settings accelerates recovery, improves motor function, and offers personalized treatment plans. By leveraging AI, these robots adapt to patient needs, ensuring effective and safe rehabilitation.

11. Which robotic system allows remote interaction between doctors and patients, enabling specialized care from a distance?

- (a) Telepresence Robots
- (b) Autonomous Cars
- (c) Warehouse Robots
- (d) Surgical Robots

Ans :

SQP 2018

- (a) Telepresence Robots

Telepresence Robots enable doctors to interact with patients remotely, making it possible to provide specialized care without physical presence. This technology is particularly useful in remote or underserved areas, enhancing access to medical expertise and improving patient care through real-time, interactive communication.

- 12.** Which robotic system automates assembly and handles dangerous materials in industrial manufacturing environments?
- Personal Assistant Robots
  - Autonomous Drones
  - Robotic Arms in Manufacturing
  - Smart Homes

**Ans :**

COMP 2011

(c) Robotic Arms in Manufacturing  
Robotic Arms in Manufacturing automate assembly processes and manage hazardous materials, thereby increasing production efficiency and enhancing workplace safety. Their use reduces human exposure to dangerous tasks and minimizes errors, making them crucial components in modern industrial production and quality control systems.

- 13.** Which system is deployed in service industries to deliver food and provide customer service in restaurants and hotels?
- Telepresence Robots
  - Robotic Waiters
  - Assistant Robots
  - Autonomous Cars

**Ans :**

MAIN 2009

(b) Robotic Waiters  
Robotic Waiters are used in restaurants and hotels to autonomously deliver food and assist with customer service tasks. By employing AI for navigation and task management, they reduce service times and enhance operational efficiency. Their deployment provides a futuristic, innovative touch to the hospitality industry.

- 14.** Which everyday robotic system employs automated control, sensors, and safety mechanisms to transport people reliably between floors?
- Elevators
  - Autonomous Cars
  - Smart Mobility
  - Warehouse Robots

**Ans :**

SQP 2014

(a) Elevators

Elevators are a common example of robotics in daily life. They use automated control systems, sensors, and robust safety mechanisms to transport people between floors efficiently. This everyday technology demonstrates how robotics can be seamlessly integrated into routine applications to enhance convenience and ensure safety.

- 15.** Which robotic system is designed to improve patient care by assisting with routine tasks and providing support in healthcare settings?
- Healthcare Assistant Robots
  - Surgical Robots
  - Telepresence Robots
  - Personal Assistant Robots

**Ans :**

COMP 2007

(a) Healthcare Assistant Robots  
Healthcare Assistant Robots perform routine tasks like medication delivery and patient monitoring, thereby reducing the workload on medical staff. Their AI integration allows them to adapt to various care environments, enhancing patient comfort and efficiency in healthcare delivery while supporting clinicians in managing patient needs effectively.

- 16.** Which AI framework is designed to operate effectively under conditions of limited knowledge and computational resources by adapting its reasoning?
- Traditional Expert Systems
  - Neural Networks
  - NARS
  - Deep Learning

**Ans :**

MAIN 2017

(c) NARS  
NARS (Non-Axiomatic Reasoning Systems) is engineered to function in environments with incomplete information and limited computational power. By adapting its reasoning based on new data, NARS effectively handles uncertainty, making it a robust alternative to traditional fixed rule-based systems and ideal for real-world applications with dynamic challenges.

- 17.** Which robotic system provides specialized support to elderly or disabled individuals by performing daily tasks and offering companionship?
- Warehouse Robots
  - Personal Assistant Robots
  - Healthcare Assistant Robots
  - Rehabilitation Robots

Ans :

SQP 2010

(c) Healthcare Assistant Robots

Healthcare Assistant Robots are designed to support the elderly and disabled by performing daily tasks and offering companionship. Their AI capabilities enable them to adapt to individual needs, reduce caregiver burdens, and improve the quality of life through consistent assistance and responsive interaction in home and care settings.

18. Which robotic system utilizes aerial capabilities to monitor crop health and provide data for precision agriculture?

- (a) Autonomous Drones
- (b) Smart Mobility
- (c) Personal Assistant Robots
- (d) Driver Assisted Cars

Ans :

COMP 2008

(a) Autonomous Drones

Autonomous Drones are employed in agriculture to capture aerial imagery and sensor data that monitor crop health. Their advanced navigation and imaging capabilities enable precision farming, allowing farmers to identify issues early, optimize resource usage, and improve overall crop management, thus enhancing agricultural productivity and sustainability.

19. Which approach integrates AI with robotics to allow machines to learn from data, adapt to environments, and improve functionality over time?

- (a) Traditional Automation
- (b) Fixed Programming
- (c) AI-Integrated Robotics
- (d) Manual Control

Ans :

MAIN 2022

(c) AI-Integrated Robotics

AI-Integrated Robotics combines artificial intelligence with mechanical systems to enable machines to learn from data and adapt to changing environments. This integration fosters continuous improvement in performance, enhances decision-making capabilities, and allows robots to handle complex tasks autonomously, thus pushing the boundaries of modern automation.

20. Which concept in AI emphasizes learning from experience rather than relying solely on pre-programmed axioms to make decisions?

- (a) Fixed Rule-Based Systems
- (b) Experience-Based Learning

(c) Axiomatic Reasoning

(d) Manual Programming

Ans :

SQP 2025

(b) Experience-Based Learning

Experience-Based Learning allows AI systems to evolve by incorporating real-world interactions and data rather than relying strictly on fixed, pre-programmed rules. This approach, as seen in frameworks like NARS, enables systems to adjust their reasoning dynamically, making them more versatile and effective in handling the uncertainties of real-world environments.

21. Which statement best describes the role of AI in modern robotic systems?

- (a) AI only controls the mechanical movements of robots.
- (b) AI enables machines to mimic human intelligence by learning from data and making decisions.
- (c) AI is used solely for powering robotic systems.
- (d) AI is irrelevant to robotic functionality.

Ans :

COMP 2021

(b) AI enables machines to mimic human intelligence by learning from data and making decisions.

Modern robotic systems integrate AI to process sensor data, adapt to environments, and improve functionality by learning from data, making decisions, and solving problems.

22. What is a major advantage of using warehouse robots such as Amazon's Kiva Robots?

- (a) They slow down the process of handling goods.
- (b) They increase human error during sorting and packing.
- (c) They enhance safety and efficiency while reducing human error.
- (d) They replace the need for any human oversight.

Ans :

MAIN 2023

(c) They enhance safety and efficiency while reducing human error.

Warehouse robots improve the efficiency and speed of handling goods, reduce human error, and enhance safety in potentially hazardous environments.

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- 23.** Which of the following is an example of an assistant robot in a household?
- A surgical robot used in minimally invasive procedures.
  - A robotic vacuum cleaner like Roomba.
  - An AI-based traffic management system.
  - A warehouse robot used for inventory management.

Ans :

SQP 2024

(b) A robotic vacuum cleaner like Roomba. Personal assistant robots in households include devices like robotic vacuum cleaners that autonomously perform daily tasks such as cleaning floors.

- 24.** What is one key benefit of smart homes as described in the material?
- They require manual monitoring of all systems.
  - They lead to increased energy consumption.
  - They allow remote monitoring and control, saving energy and enhancing security.
  - They are designed solely for entertainment purposes.

Ans :

COMP 2013

(c) They allow remote monitoring and control, saving energy and enhancing security. Smart homes use integrated devices and sensors to provide remote monitoring and control, which can result in energy savings and increased safety.

- 25.** Which statement best describes smart mobility?
- It solely involves interactive smart boards in schools.
  - It refers to the integration of technology in transportation, such as AI-based traffic management and connected vehicles.
  - It is limited to enhancing healthcare procedures.
  - It excludes any use of AI in vehicle control.

Ans :

MAIN 2016

(b) It refers to the integration of technology in transportation, such as AI-based traffic management and connected vehicles. Smart mobility revolutionizes transportation by using technology to manage traffic, improve vehicle control, reduce congestion, and enhance overall safety.

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- 26.** What distinguishes autonomous cars from driver-assisted cars?
- Autonomous cars require constant human intervention for navigation.
  - Autonomous cars navigate independently using sensors, cameras, and advanced algorithms.
  - Driver-assisted cars completely replace the driver's role.
  - Autonomous cars are used only in agricultural settings.

Ans :

SQP 2015

(b) Autonomous cars navigate independently using sensors, cameras, and advanced algorithms. Autonomous cars are designed to operate without human intervention by relying on a suite of sensors and algorithms, while driver-assisted cars provide additional support features (e.g., adaptive cruise control) but still require human control.

- 27.** Which of the following is NOT an application of autonomous drones mentioned in the material?
- Package delivery services.
  - Crop monitoring in agriculture.
  - Surveillance and aerial photography.
  - Operating warehouse inventory systems.

Ans :

COMP 2019

(d) Operating warehouse inventory systems. While autonomous drones are used for tasks such as package delivery, crop monitoring, and surveillance, the material does not indicate their use in managing warehouse inventory systems, which are typically handled by ground-based robots.

- 28.** In the context of robotics for medicine and healthcare, what is one major benefit of surgical robots like the da Vinci Surgical System?
- They increase the complexity of surgical procedures.
  - They reduce the precision of surgical operations.
  - They provide increased precision during surgeries, leading to reduced recovery times.
  - They eliminate the need for any human surgeons.

Ans :

MAIN 2006

(c) They provide increased precision during surgeries, leading to reduced recovery times. Surgical robots assist in minimally invasive procedures by enhancing precision, which can

lead to fewer complications and faster recovery times for patients.

- 29.** Which statement accurately reflects the use of robotic systems in everyday life?
- Elevators operate solely on manual controls without sensors.
  - Robotic arms in manufacturing are outdated and rarely used.
  - Elevators are an example of everyday robotic systems that use sensors, control algorithms, and safety mechanisms.
  - Service robots are only theoretical and not found in actual restaurants or hotels.

**Ans :**

SQP 2012

(c) Elevators are an example of everyday robotic systems that use sensors, control algorithms, and safety mechanisms.

Elevators incorporate automated control systems, including sensors and safety mechanisms, demonstrating that robotics is integrated into daily life beyond high-tech laboratories.

- 30.** What is the primary purpose of Non-Axiomatic Reasoning Systems (NARS) in robotics?
- To enforce rigid, axiomatic rules that cannot be changed.
  - To handle uncertainty and incomplete information, enabling real-time decision-making in dynamic environments.
  - To eliminate the need for any learning or adaptation in robotic systems.
  - To limit robotic systems to pre-programmed responses only.

**Ans :**

COMP 2018

(b) To handle uncertainty and incomplete information, enabling real-time decision-making in dynamic environments.

NARS is specifically designed to operate under conditions of insufficient knowledge and limited computational resources. It allows robotic systems to adapt and make decisions based on experience and changing information in real-world scenarios.

- 31.** A large e-commerce company struggles with order processing speed and accuracy. To automate sorting, packing, and transporting items in its vast warehouse, which robotic system should it adopt?
- Autonomous Drones
  - Warehouse Robots
  - Smart Homes

(d) Assistant Robots

**Ans :**

MAIN 2011

(b) Warehouse Robots

Warehouse robots, exemplified by Amazon's Kiva robots, are purpose-built for automating sorting, packing, and transport tasks in large warehouses. Their AI integration ensures rapid data processing, efficiency, reduced human error, and increased safety. This case demonstrates why investing in warehouse robotics significantly improves productivity and meets high-demand order processing requirements.

- 32.** A senior living community wants to support residents' daily routines and improve their quality of life with minimal human intervention. Which robotic system best meets this need?

- Warehouse Robots
- Assistant Robots
- Autonomous Drones
- Robotics for Medicine

**Ans :**

SQP 2009

(b) Assistant Robots

Assistant robots, including personal assistants and healthcare aides, are designed to help with daily tasks and specialized support. They improve quality of life by managing routine chores and providing companionship. In this scenario, deploying assistant robots in a senior living community would decrease human labor while ensuring reliable, supportive services.

- 33.** A homeowner desires a residence upgrade that enhances convenience, security, and energy efficiency through automation of lighting, heating, and security. Which integrated system is most appropriate?

- Smart Mobility
- Autonomous Cars
- Smart Homes
- Warehouse Robots

**Ans :**

COMP 2014

(c) Smart Homes

Smart Homes utilize interconnected devices and sensors to automate systems like lighting, heating, and security. Integrating advanced AI-powered features such as facial recognition for entry, these homes enable remote monitoring, energy savings, and increased safety. This innovative technology meets the homeowner's need for enhanced convenience and security in daily living.

- 34.** A school district plans to implement advanced technology to boost student engagement and personalize education. Which system best fits this scenario, and what are its key benefits?

(a) Smart Mobility  
(b) Smart Schools  
(c) Autonomous Drones  
(d) Warehouse Robots

**Ans :**

MAIN 2007

(b) Smart Schools

Smart Schools integrate interactive smart boards and AI-driven teaching assistants to create engaging, personalized learning environments. This system improves student engagement, enables tailored educational experiences, and streamlines resource management. Implementing smart school technology effectively empowers educators to optimize teaching methods and supports efficient scheduling and administration.

- 35.** A city government aims to reduce traffic congestion, lower emissions, and enhance road safety using technology. Which system directly addresses these issues, and what technology does it employ?

(a) Autonomous Drones  
(b) Smart Mobility  
(c) Assistant Robots  
(d) Smart Homes

**Ans :**

SQP 2017

(b) Smart Mobility

Smart Mobility integrates AI-based traffic management systems and connected vehicles to optimize traffic flow, reduce congestion, and lower emissions. By enabling vehicles to communicate with each other and surrounding infrastructure, this technology enhances road safety and efficiency. The system is specifically designed to address urban transportation challenges through data-driven solutions.

- 36.** A transportation company seeks vehicles with features like adaptive cruise control, lane-keeping, and automatic braking to improve road safety. Which type of vehicle best fits these characteristics?

(a) Autonomous Drones  
(b) Assistant Robots  
(c) Autonomous Cars / Driver Assisted Cars  
(d) Warehouse Robots

**Ans :**

COMP 2010

(c) Autonomous Cars / Driver Assisted Cars

Autonomous Cars and Driver Assisted Cars incorporate advanced sensors, cameras, and algorithms to enable features such as adaptive cruise control, lane-keeping, and automatic braking. These vehicles enhance road safety and provide mobility support for individuals unable to drive. Their robotics and AI integration marks a major advancement in transportation safety.

- 37.** A logistics company needs a versatile system for last-mile delivery, crop monitoring, and surveillance tasks. Which robotic system is most effective, and what advantage does it offer?

(a) Autonomous Drones  
(b) Smart Homes  
(c) Robotics for Medicine  
(d) Smart Mobility

**Ans :**

MAIN 2008

(a) Autonomous Drones

Autonomous drones are unmanned aerial vehicles that operate independently using AI for navigation and task execution. They are ideal for applications such as package delivery, agricultural crop monitoring, and surveillance. Their ability to access remote or hazardous areas makes them cost-effective, efficient, and versatile solutions for logistics and monitoring challenges.

- 38.** A hospital is evaluating technology to assist with minimally invasive surgeries and patient rehabilitation. Which application from the passage is most relevant, and what benefits does it provide?

(a) Robotics for Medicine and Healthcare  
(b) Smart Mobility  
(c) Autonomous Drones  
(d) Warehouse Robots

**Ans :**

SQP 2022

(a) Robotics for Medicine and Healthcare

Robotics for Medicine and Healthcare encompasses surgical robots, rehabilitation devices, robotic prosthetics, and telepresence systems. These technologies increase surgical precision, reduce recovery times, and provide improved patient care. Implementing such systems enhances access to specialized medical procedures and supports effective rehabilitation, thereby advancing healthcare outcomes and patient quality of life.

39. An urban building manager wants to improve daily operational safety and efficiency. Which everyday robotic system from the passage would be most applicable, and what is its primary function?

(a) Elevators  
(b) Autonomous Cars  
(c) Smart Homes  
(d) Warehouse Robots

Ans :

MAIN 2025

(a) Elevators

Elevators are everyday robotic systems that utilize automated control, sensors, and safety mechanisms to transport people efficiently between floors. Their integration of robotic principles ensures reliable operation and enhanced safety. This case illustrates that robotics extend beyond advanced laboratories into routine applications, significantly improving daily building functionality and occupant convenience.

40. A smart home system encounters unpredictable conditions and incomplete sensor data. Which AI framework should be implemented to adapt effectively, and why?

(a) Traditional AI with fixed axioms  
(b) Non-Axiomatic Reasoning System (NARS)  
(c) Autonomous Drone Algorithms  
(d) Basic Robotic Control Systems

Ans :

SQP 2021

(b) Non-Axiomatic Reasoning System (NARS)

Non-Axiomatic Reasoning Systems (NARS) are designed to function with insufficient knowledge and limited computational resources. They adapt in real-world, unpredictable environments by learning from experience instead of relying on fixed axioms. Implementing NARS in smart home systems enables effective decision-making and error handling, ensuring robust, adaptable, efficient performance under uncertainty.

## ASSERTION AND REASON

41. **Assertion (A) :** NARS-based robotic systems are well-suited for real-world applications because they can adapt to incomplete information and limited computational resources.

**Reason (R) :** Unlike traditional AI systems that depend on fixed axioms, NARS employs a non-axiomatic reasoning approach that adjusts as new

data becomes available.

### Options

- (a) Both A and R are true, and R is the correct explanation of A.  
(b) Both A and R are true, but R is not the correct explanation of A.  
(c) A is true, but R is false.  
(d) A is false, but R is true.

Ans :

(a) Both A and R are true, and R is the correct explanation of A.

The provided material explains that NARS (Non-Axiomatic Reasoning System) is specifically designed for conditions with insufficient knowledge and limited resources. Its non-axiomatic approach (i.e., not relying on fixed rules) enables it to adapt in dynamic, real-world environments, making R the correct explanation for A.

42. **Assertion (A) :** Autonomous drones offer cost-effective and efficient solutions for monitoring remote or hazardous areas.

**Reason (R) :** Autonomous drones utilize AI-driven navigation and task execution, allowing them to operate independently without human intervention.

### Options

- (a) A is true, but R is false.  
(b) Both A and R are true, but R is not the correct explanation of A.  
(c) Both A and R are true, and R is the correct explanation of A.  
(d) A is false, but R is true.

Ans :

(c) Both A and R are true, and R is the correct explanation of A.

The material highlights that autonomous drones are used for tasks such as package delivery, agriculture monitoring, and surveillance. Their AI-based navigation and independence from human control directly contribute to their cost-effectiveness and efficiency, making the reason the proper explanation for the assertion.

43. **Assertion (A) :** Smart mobility systems reduce traffic congestion and enhance road safety.

**Reason (R) :** Smart mobility integrates AI-based traffic management systems and vehicle-to-vehicle/infrastructure communication, which optimize traffic flow and vehicle control.

### Options

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

- (a) Both A and R are true, and R is the correct explanation of A.

According to the provided information, smart mobility employs advanced AI technologies to manage traffic and enable communication among vehicles. This integration leads to reduced congestion and improved safety, confirming that the reason correctly explains the assertion.

- 44. Assertion (A) :** NARS-based robotic systems are ideal for real-world applications because they can adjust to incomplete information and limited computational resources.

**Reason (R) :** Unlike traditional AI systems that rely on fixed, axiomatic rules, NARS employs a non-axiomatic reasoning approach that adapts as new data becomes available.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

- (a) Both A and R are true, and R is the correct explanation of A.

The material clearly explains that NARS is designed to handle uncertainty by adapting its reasoning to new data, which directly explains why such systems are suitable for real-world conditions.

- 45. Assertion (A) :** Driver assisted cars operate completely without any human intervention.

**Reason (R) :** They are equipped with features such as adaptive cruise control, lane-keeping assist, and automatic braking.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

- (d) A is false, but R is true.

While the reason correctly describes the features of driver assisted cars, the assertion is false because these vehicles still require human oversight. Thus, A is false, and R is true.

- 46. Assertion (A) :** Smart homes depend solely on facial recognition systems for security.

**Reason (R) :** They integrate various AI-powered devices and sensors, including automated lighting, heating systems, and security systems.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

- (d) A is false, but R is true.

The assertion is false because smart homes use a range of sensors and systems for security—not just facial recognition. The reason is true, making option (d) the correct choice.

- 47. Assertion (A) :** Surgical robots significantly reduce patient recovery times by performing minimally invasive procedures.

**Reason (R) :** They increase the precision of surgical operations, thereby reducing tissue damage during procedures.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

- (a) Both A and R are true, and R is the correct explanation of A.

The provided material shows that surgical robots, by enhancing precision through minimally invasive techniques, reduce tissue damage and thus help shorten recovery times. Therefore, both statements are true with R correctly explaining A.

- 48. Assertion (A) :** Warehouse robots help reduce human error in logistics operations.

**Reason (R) :** They are widely deployed by companies like Amazon in warehouse operations.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

(b) Both A and R are true, but R is not the correct explanation of A.

While it is true that warehouse robots reduce human error by automating tasks, the reason merely states that they are used by companies such as Amazon without explaining how they reduce errors. Hence, both statements are true, but R does not correctly explain A.

- 49. Assertion (A) :** Autonomous drones are ineffective in accessing hazardous or remote areas.

**Reason (R) :** They utilize AI-based navigation and sensor technology to operate independently.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

(d) A is false, but R is true.

The assertion is false because the material states that autonomous drones are highly effective in reaching hazardous or remote areas. The reason is true, making option (d) correct.

- 50. Assertion (A) :** Smart mobility systems contribute to lower vehicular emissions.

**Reason (R) :** They optimize traffic flow and vehicle control through AI-based traffic management and vehicle-to-vehicle/infrastructure communication.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

(a) Both A and R are true, and R is the correct explanation of A.

The material indicates that smart mobility systems reduce congestion and improve safety by optimizing traffic management. This efficiency indirectly contributes to lower emissions, making R the correct explanation of A.

- 51. Assertion (A) :** Telepresence robots require the physical presence of a doctor to provide specialized care.

**Reason (R) :** They enable doctors to interact with patients remotely.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

(d) A is false, but R is true.

The assertion is false because telepresence robots are specifically designed to allow remote interaction, eliminating the need for physical presence. The reason is true, so the correct answer is (d).

- 52. Assertion (A) :** Robotic arms in manufacturing are used exclusively for assembling products.

**Reason (R) :** They are also employed to handle dangerous materials.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

(d) A is false, but R is true.

The assertion is false because robotic arms have multiple applications (including handling dangerous materials), not just assembling products. The reason is true, making option (d) correct.

- 53. Assertion (A) :** Personal assistant robots, such as robotic vacuum cleaners, are designed to help with household chores.

**Reason (R) :** They primarily function by scanning barcodes on products.

**Options**

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

**Ans :**

- (c) A is true, but R is false.

The assertion is true as personal assistant robots are indeed designed to help with household tasks. However, the reason is false because robotic vacuum cleaners operate using sensors and mapping technology—not by scanning barcodes on products.

## STATEMENT BASED QUESTIONS

**54.** Consider the following statements about the definitions of robotics and AI :

1. Robotics involves designing, constructing, and operating robots—machines that can perform tasks automatically or with minimal human intervention.
  2. AI (Artificial Intelligence) enables machines to mimic human intelligence by learning from data, making decisions, and solving problems.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

The material clearly defines robotics as the field that deals with building and operating robots and describes AI as the technology that allows machines to learn and make decisions, so both statements are accurate.

**55.** Consider the following statements regarding the integration of AI into modern robotic systems :

1. Modern robotic systems often integrate AI to process sensor data, adapt to their environments, and improve functionality.
  2. Modern robotic systems rely solely on fixed, pre-programmed instructions and do not incorporate any adaptive AI components.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.

- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Statement 1 accurately reflects the trend of integrating AI into robotics for adaptability and enhanced functionality, while statement 2 is incorrect because it ignores the adaptive nature of modern systems.

**56.** Consider the following statements about warehouse robots :

1. Warehouse robots, such as Amazon's Kiva Robots, automate tasks like sorting, packing, transporting, and inventory management, thereby increasing efficiency, reducing human error, and enhancing safety.
  2. Warehouse robots are primarily used for entertainment in retail environments rather than operational efficiency.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

The material cites warehouse robots as examples of systems that enhance operational efficiency, safety, and accuracy; statement 2 is not supported by the text.

**57.** Consider the following statements about assistant robots :

1. Personal assistant robots, like robotic vacuum cleaners (e.g., Roomba), autonomously clean floors.
  2. Healthcare assistant robots help elderly or disabled individuals by performing routine tasks or providing companionship.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

The material provides examples of both personal assistant robots (like Roomba) and healthcare assistants that aid in routine tasks and companionship.

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**58.** Consider the following statements regarding smart homes :

1. Smart homes use integrated devices and sensors to create connected environments that enhance convenience, security, and energy efficiency.
  2. In smart homes, all systems must be manually controlled with no capability for remote monitoring or automation.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.

Statement 1 accurately describes smart home technology; statement 2 contradicts the benefits of automation and remote control that are central to smart home systems.

**59.** Consider the following statements about autonomous cars and driver-assisted cars :

1. Autonomous cars use sensors, cameras, and advanced algorithms to navigate without human intervention.
  2. Driver-assisted cars offer features such as adaptive cruise control, lane-keeping assist, and automatic braking, yet still require human oversight for navigation.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

The material distinguishes between fully autonomous vehicles and driver-assisted systems; both statements accurately describe these two types of automotive technology.

**60.** Consider the following statements about autonomous drones :

1. Autonomous drones operate independently using AI for navigation and task execution, such as package delivery, agricultural monitoring, and surveillance.
  2. Autonomous drones are used exclusively for recreational photography and have no significant commercial or practical applications.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.

(c) Both statements 1 and 2 are correct.

(d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.

The text provides multiple commercial and practical examples for autonomous drones; statement 2 is incorrect because it limits their use to recreational photography, which is not supported by the material.

**61.** Consider the following statements regarding robotics for medicine and healthcare :

1. Surgical robots, such as the da Vinci Surgical System, assist in minimally invasive surgeries, thereby improving precision and reducing recovery times.
  2. Robotic prosthetics and telepresence robots are used to enhance patient care and rehabilitation.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

Both statements are supported by the material, which highlights various applications of robotics in medicine, including surgical assistance, prosthetics, and telepresence.

**62.** Consider the following statements about other examples of robotic systems in everyday life :

1. Elevators are everyday examples of robotic systems that use automated control systems incorporating sensors, control algorithms, and safety mechanisms to move efficiently between floors.
  2. Robotic arms in manufacturing and robotic waiters or service robots demonstrate that robotics is widely integrated into daily life for enhanced convenience and safety.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

The material includes elevators, robotic arms, and service robots as examples of how robotics is applied in various everyday contexts to improve efficiency and safety.

**63.** Consider the following statements about NARS (Non-Axiomatic Reasoning Systems) :

1. NARS is an AI framework designed to operate under conditions of insufficient knowledge and limited computational resources, making it adaptable to real-world situations with uncertainty.
  2. Unlike NARS, traditional AI systems rely strictly on fixed, axiomatic rules and cannot handle uncertainty or incomplete information.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.  
 Statement 1 accurately defines NARS and its ability to function with incomplete knowledge and limited resources. Statement 2 contrasts NARS with traditional AI systems that depend on fixed axioms, which is also correct.

## PICTURE BASED QUESTIONS

**64.** An image shows a robot picking up items in a warehouse using AI-based navigation. What is the primary advantage of such a system?



- (a) Increased efficiency and reduced human error  
 (b) Increased manual labor  
 (c) Higher operational costs  
 (d) Less productivity in sorting

**Ans :**

(a) Increased efficiency and reduced human error  
 Warehouse robots use AI-powered navigation and automation to enhance efficiency, minimize

errors, and improve safety while managing large inventories.

**65.** An image shows a robotic vacuum cleaner (e.g., Roomba) autonomously cleaning a room. What type of robot is this?

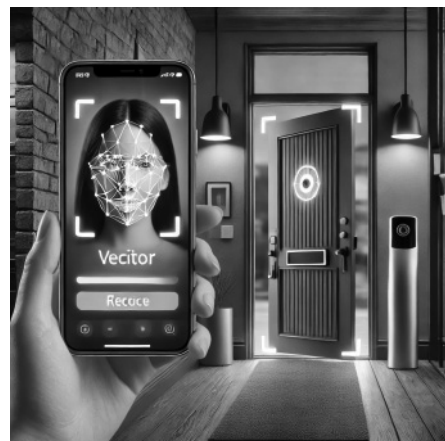


- (a) Warehouse Robot  
 (b) Assistant Robot  
 (c) Smart Drone  
 (d) Industrial Robot

**Ans :**

(b) Assistant Robot  
 Assistant robots aid humans in daily tasks, such as cleaning, healthcare assistance, or personal support, improving convenience and quality of life.

**66.** An image shows an AI-powered smart home security system with facial recognition. What is one of the main advantages of such a system?



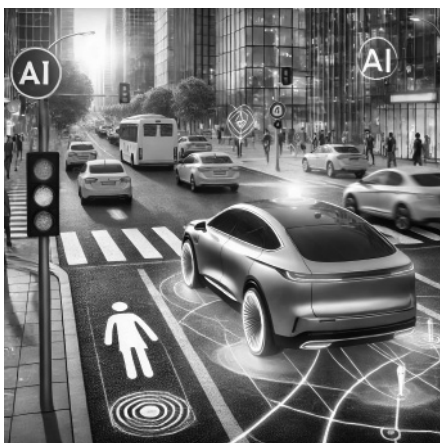
- (a) Remote monitoring and security  
 (b) Increased manual intervention  
 (c) Slower response time  
 (d) Higher energy consumption

Ans :

- (a) Remote monitoring and security

Smart homes integrate AI-powered security systems for remote access, automation, and real-time alerts, enhancing safety and energy efficiency.

67. An image shows a self-driving car navigating a busy road using sensors and AI. What is a major benefit of autonomous cars?

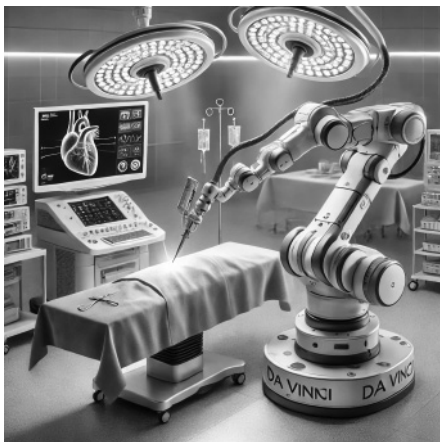


- (a) Increased road safety and reduced accidents  
 (b) Higher reliance on human drivers  
 (c) Decreased transportation efficiency  
 (d) More traffic congestion

Ans :

(a) Increased road safety and reduced accidents  
 Autonomous cars use AI, sensors, and advanced algorithms to reduce human errors, improving road safety and reducing traffic accidents.

68. An image shows a robotic arm assisting in surgery using the da Vinci Surgical System. What is the key advantage of robotic-assisted surgeries?



- (a) Increased precision and faster recovery times  
 (b) Higher risk and human errors

- (c) More invasive procedures  
 (d) Reduced accuracy in surgery

Ans :

(a) Increased precision and faster recovery times  
 Robotic surgical systems enhance precision, reduce recovery times, and allow for minimally invasive procedures, improving patient outcomes.

69. An image shows an autonomous drone delivering a package to a doorstep. Which industry benefits most from this technology?



- (a) Agriculture  
 (b) E-commerce and delivery services  
 (c) Sports  
 (d) Banking

Ans :

(b) E-commerce and delivery services  
 Autonomous drones are widely used in e-commerce and logistics, enabling fast and efficient package delivery, reducing reliance on manual transport.

70. An image shows an AI-powered smart home assistant adapting to unexpected events, such as a sudden power outage. What AI framework is best suited for such adaptability?



NODIA

- (a) Rule-Based AI
- (b) NARS (Non-Axiomatic Reasoning System)
- (c) Simple Automation
- (d) Fixed Logic Circuits

**Ans :**

(b) NARS (Non-Axiomatic Reasoning System)  
NARS allows AI systems to reason under uncertainty and adapt to incomplete information, making it ideal for real-world dynamic environments like smart homes and autonomous vehicles.

## TWO MARKS QUESTIONS

- 71.** What are two key roles that AI plays in modern robotic systems?

**Ans :** MAIN 2025

- 1. Learning from Data : AI enables robots to learn from sensor data and past experiences.
- 2. Adaptive Decision Making : AI allows robots to make real-time decisions and adapt to changing environments.

- 72.** List two advantages of using warehouse robots in industrial applications.

**Ans :** SQP 2021

- 1. Increased Efficiency : They speed up tasks like sorting, packing, and inventory management.
- 2. Reduction in Human Error : Automated processes help minimize mistakes during operations.

- 73.** Name two examples of assistant robots and state one benefit for each.

**Ans :** COMP 2023

- 1. Personal Assistant Robots (e.g., Roomba) : They autonomously perform household chores, reducing manual effort.
- 2. Healthcare Assistants : They help elderly or disabled individuals by assisting with daily tasks and providing companionship.

- 74.** Identify two core features of smart home systems.

**Ans :** MAIN 2024

- 1. Remote Monitoring and Control : Homeowners can manage devices from anywhere using smart devices.

- 2. Energy Efficiency : Automated systems like smart lighting and heating help reduce energy consumption.

- 75.** What are two examples of smart school technologies and one advantage they provide?

**Ans :** SQP 2013

- 1. Interactive Smart Boards : They enhance classroom engagement and interactive learning.
- 2. AI-driven Teaching Assistants : They help personalize the learning experience and manage school resources efficiently.

- 76.** List two advantages of smart mobility systems in urban transportation.

**Ans :** COMP 2016

- 1. Reduced Congestion : AI-based traffic management systems optimize vehicle flow.
- 2. Enhanced Safety : Connected vehicles and real-time monitoring contribute to safer road conditions.

- 77.** Differentiate between autonomous cars and driver-assisted cars by providing one key feature of each.

**Ans :** MAIN 2015

- 1. Autonomous Cars : They navigate without human intervention using sensors, cameras, and advanced algorithms.
- 2. Driver-Assisted Cars : They feature technologies like adaptive cruise control and lane-keeping assist to aid drivers.

- 78.** Give two examples of applications for autonomous drones.

**Ans :** SQP 2019

- 1. Package Delivery : For instance, drones like those used in Amazon Prime Air transport packages.
- 2. Agricultural Monitoring : Drones monitor crops and provide aerial surveillance for better farm management.

- 79.** What are two advantages of using robotic systems in medicine and healthcare?

**Ans :** COMP 2006

- 1. Increased Precision : Surgical robots like the da Vinci system enable minimally invasive and precise surgeries.

2. Enhanced Patient Care : Telepresence and rehabilitation robots improve patient outcomes and access to care.

- 80.** Identify two examples of robotics in everyday systems outside high-tech laboratories.

**Ans :** MAIN 2012

1. Elevators : They use automated control systems, sensors, and safety mechanisms to operate efficiently.
2. Robotic Arms in Manufacturing : They assemble products and handle materials in hazardous environments.

- 81.** What does NARS stand for, and what is one of its key conceptual advantages?

**Ans :** SQP 2018

1. NARS : It stands for Non-Axiomatic Reasoning System.
2. Advantage : It can handle uncertainty and incomplete information, making it adaptable for real-world applications.

- 82.** Explain two reasons why NARS is considered practical for robotic systems.

**Ans :** COMP 2011

1. Adaptability : NARS can adjust its reasoning based on new data in unpredictable environments.
2. Efficiency : It is optimized for systems with limited computational resources, making it ideal for embedded applications.

- 83.** List two benefits of integrating AI into warehouse robotics.

**Ans :** MAIN 2009

1. Improved Navigation : AI helps robots efficiently navigate the warehouse floor.
2. Enhanced Task Management : AI-powered decision making improves sorting, packing, and delivery accuracy.

- 84.** What are two ways in which assistant robots enhance daily living?

**Ans :** SQP 2014

1. Labor Reduction : They automate routine tasks, reducing the burden on humans.
2. Improved Assistance : In healthcare, they support the elderly and disabled, improving their quality of life.

- 85.** Identify two advantages provided by smart home technologies.

**Ans :** COMP 2007

1. Convenience : Automation of lighting, heating, and security systems simplifies daily living.
2. Safety and Energy Savings : AI-powered systems enhance security and manage energy usage efficiently.

- 86.** Name two smart school features that contribute to personalized learning.

**Ans :** MAIN 2017

1. Interactive Smart Boards : They allow dynamic content delivery and interactive lessons.
2. AI-driven Teaching Assistants : They help tailor educational content to individual student needs.

- 87.** How do autonomous cars contribute to improved road safety? Provide two points.

**Ans :** SQP 2010

1. Reduced Human Error : They minimize mistakes caused by driver fatigue or distraction.
2. Enhanced Vehicle Control : Advanced sensors and algorithms help maintain optimal driving conditions.

- 88.** List two applications of autonomous drones and one advantage for each.

**Ans :** COMP 2008

1. Surveillance and Aerial Photography : They offer efficient monitoring of large or inaccessible areas.
2. Agricultural Crop Monitoring : They help in the cost-effective management and analysis of crop health.

- 89.** What are two benefits of robotic systems used in healthcare procedures?

**Ans :** MAIN 2022

1. Precision in Surgery : Robotic systems enable minimally invasive procedures with high accuracy.
2. Accelerated Rehabilitation : Rehabilitation robots assist patients in regaining movement post-injury.

- 90.** Identify two examples of non-laboratory robotic systems mentioned in the material and state their significance.

**Ans :** SQP 2024

1. Elevators : They demonstrate how automated control systems are integrated into everyday life for efficient vertical transportation.
2. Robotic Arms in Manufacturing : They highlight the role of robotics in enhancing productivity and ensuring safety by handling dangerous tasks.

### THREE MARKS QUESTIONS

- 91.** Discuss two benefits of using robotics in warehouse management.

**Ans :** MAIN 2025

1. Increased Efficiency : Robotics streamlines operations by automating repetitive tasks such as sorting, packing, and inventory tracking. This automation reduces processing time and enhances throughput, allowing warehouses to handle larger volumes of goods with consistent speed and accuracy.
2. Reduction in Human Error : Automated systems significantly lower the risk of mistakes that can occur with manual handling. By ensuring precise movements and consistent performance, robotics minimizes misplacements and damage, which contributes to overall operational reliability and improved customer satisfaction.

- 92.** Identify two features of assistant robots that improve daily living.

**Ans :** SQP 2024

1. Autonomous Operation : Assistant robots, such as robotic vacuum cleaners, operate independently to perform household tasks without constant human supervision. Their ability to navigate complex home environments and adjust to obstacles makes daily chores easier and frees up time for users.
2. Healthcare Support : Some assistant robots are designed to provide support in healthcare settings, aiding the elderly or disabled in routine tasks. These robots not only offer physical assistance but also provide

companionship, which can enhance the overall quality of life for individuals with limited mobility.

- 93.** Explain two advantages of smart home systems.

**Ans :** COMP 2021

1. Remote Monitoring and Control : Smart home systems allow users to manage and monitor home devices from anywhere using smart phones or tablets. This connectivity means that homeowners can adjust settings, receive alerts, and ensure security even when they are not physically present, thereby increasing convenience and peace of mind.
2. Energy Efficiency : Automated controls in smart homes optimize the use of energy by adjusting lighting, heating, and cooling based on occupancy and time of day. This dynamic management leads to significant energy savings and a reduced environmental footprint, while also lowering utility bills.

- 94.** Describe two ways in which smart schools utilize technology to enhance learning.

**Ans :** MAIN 2023

1. Interactive Smart Boards : Smart boards in classrooms allow teachers to present dynamic, multimedia content that engages students more effectively than traditional boards. These interactive displays support a variety of teaching methods and provide instant feedback, which can help in clarifying complex concepts.
2. AI-Driven Teaching Assistants : AI-based assistants help in personalizing education by adapting to each student's learning pace and style. They can analyze performance data to suggest customized exercises and track progress, thereby enhancing the overall educational experience.

- 95.** List two advantages of smart mobility systems in modern transportation.

**Ans :** SQP 2013

1. Reduced Traffic Congestion : Smart mobility systems employ AI-driven traffic management tools to optimize traffic flow and reduce congestion. By analyzing real-time data, these systems can adjust traffic signals and reroute vehicles to prevent bottlenecks and improve overall travel times.

2. Enhanced Road Safety : Connected vehicles and intelligent transportation systems use real-time communication to warn drivers of hazards and coordinate movements. This improved coordination helps in preventing accidents and ensures a smoother, safer journey for all road users.

**96.** Compare two features of autonomous cars and driver-assisted cars.

**Ans :**

COMP 2016

1. Autonomous Cars : These vehicles are equipped with advanced sensors, cameras, and AI algorithms that allow them to navigate without any human intervention. Their ability to process vast amounts of data in real time enables them to make complex driving decisions and adapt to changing road conditions automatically.
2. Driver-Assisted Cars : Driver-assisted vehicles provide features like adaptive cruise control, lane-keeping assist, and automatic braking to support the driver. While the driver remains in control, these systems help reduce the cognitive load and enhance safety by mitigating potential errors during driving.

**97.** Discuss two applications of autonomous drones in various industries.

**Ans :**

MAIN 2015

1. Package Delivery : Autonomous drones are increasingly used for package delivery, as seen with services like Amazon Prime Air. Their ability to fly directly to a destination reduces delivery times and bypasses ground traffic, offering a rapid and efficient logistics solution.
2. Agricultural Monitoring : In agriculture, drones are utilized for aerial surveillance and crop monitoring. They collect high-resolution images and sensor data that help farmers assess crop health, monitor irrigation systems, and manage resources more effectively.

**98.** Identify two roles of robotics in healthcare.

**Ans :**

SQP 2019

1. Surgical Assistance : Robotics plays a critical role in surgical procedures by providing high-precision tools that enable minimally invasive surgeries. Systems like the da Vinci Surgical System offer enhanced control and stability, allowing surgeons to perform delicate

operations with reduced recovery times for patients.

2. Rehabilitation Support : Robotic devices in rehabilitation help patients recover mobility and strength following injuries or surgeries. By delivering consistent, repeatable movements, these systems facilitate structured therapy sessions and can be tailored to meet individual patient needs, accelerating the rehabilitation process.

**99.** Explain two benefits of telepresence robots in healthcare.

**Ans :**

COMP 2006

1. Remote Interaction : Telepresence robots enable doctors and healthcare providers to interact with patients from remote locations. This technology allows for real-time communication and visual assessments, which is particularly beneficial for patients in underserved or rural areas who may not have easy access to specialized care.
2. Increased Access to Care : With telepresence robots, healthcare services can be extended to patients who are unable to visit medical facilities easily. This increased accessibility ensures that more patients receive timely medical attention and continuous monitoring, improving overall healthcare outcomes.

**100.** Describe two examples of everyday robotic systems outside high-tech laboratories.

**Ans :**

MAIN 2012

1. Elevators : Modern elevators utilize automated control systems, sensors, and safety protocols to efficiently transport passengers between floors. Their integration of robotics ensures smooth operation, precise stopping, and rapid response to user requests, making them a vital part of urban infrastructure.
2. Robotic Arms in Manufacturing : Robotic arms are extensively used in manufacturing for tasks such as assembly, welding, and material handling. Their precision and strength enable them to perform repetitive and hazardous tasks with high accuracy, significantly enhancing production efficiency and worker safety.

**101.** Discuss two advantages of integrating robotic waiters in the hospitality industry.

**Ans :**

SQP 2018

1. **Enhanced Customer Service :** Robotic waiters can provide consistent and timely service by delivering orders directly to tables without delay. Their automated operations reduce wait times and ensure that customers receive prompt attention, thereby improving the overall dining experience.
2. **Reduced Workload on Staff :** By taking over routine delivery and service tasks, robotic waiters allow human staff to focus on more complex interactions and personalized service. This redistribution of tasks leads to a more efficient workflow in restaurants and hotels and can improve employee satisfaction.

**102.** Identify two ways robotics enhances safety in industrial environments.

**Ans :**

COMP 2011

1. **Handling Dangerous Materials :** Robotics can perform tasks in hazardous environments, such as handling toxic chemicals or operating in high-temperature conditions. This capability minimizes human exposure to dangerous substances and reduces the risk of injury or accidents in industrial settings.
2. **Automated Operations :** Robotic systems are programmed to execute tasks with high precision and consistency, significantly lowering the chance of human error. By automating critical processes, these systems enhance overall operational safety and contribute to a more secure working environment.

**103.** Explain two key features of Non-Axiomatic Reasoning Systems (NARS).

**Ans :**

MAIN 2009

1. **Adaptability :** NARS is designed to adjust its reasoning based on new or incomplete information, which is crucial in dynamic and unpredictable environments. This flexibility allows robotic systems to maintain functionality and make informed decisions even when operating under uncertain conditions.
2. **Efficiency Under Constraints :** NARS operates effectively within systems that have limited computational resources. Its ability to deliver reliable performance without requiring extensive processing power makes it an ideal choice for embedded systems and real-time applications in robotics.

**104.** Discuss two reasons why NARS is suitable for real-world robotic applications.

**Ans :**

SQP 2014

1. **Handling Uncertainty :** NARS excels in managing scenarios with incomplete or conflicting data, enabling robots to function reliably in complex real-world situations. Its capacity to adapt its reasoning process in real time ensures that the system can cope with the inherent unpredictability of everyday environments.
2. **Resource Optimization :** NARS is specifically designed to work efficiently with limited computational resources, which is common in many robotic platforms. This optimization allows for effective decision-making and control without the need for high-end hardware, making it practical for a wide range of applications.

**105.** Describe two advantages of AI-based traffic management systems in smart mobility.

**Ans :**

COMP 2007

1. **Optimized Traffic Flow :** AI-based systems analyze real-time traffic data to optimize signal timings and vehicle routing. This dynamic adjustment helps to reduce congestion, ensuring a smoother flow of vehicles and minimizing delays during peak traffic hours.
2. **Improved Safety :** By continuously monitoring traffic conditions and communicating with connected vehicles, these systems can quickly identify and respond to potential hazards. This proactive approach contributes to a reduction in accidents and promotes a safer travel environment for all road users.

**106.** List two examples of how AI improves decision-making in robotic systems.

**Ans :**

MAIN 2017

1. **Sensor Data Processing :** AI algorithms integrate and analyze data from multiple sensors, enabling robots to create a comprehensive understanding of their environment. This capability allows robots to make precise and informed decisions when navigating complex or changing conditions.
2. **Adaptive Responses :** AI-driven systems can adjust their behavior in real time based on continuous feedback from the environment.

This adaptability ensures that robots can respond effectively to unexpected obstacles or changes, thereby improving overall operational performance.

- 107.** Explain two benefits of automation in manufacturing robotics.

**Ans :**

SQP 2010

1. **Increased Production Speed :** Automation in manufacturing enables robotic systems to perform repetitive tasks at a much faster rate than manual labor. This rapid operation significantly boosts production output and ensures that products are assembled with consistent quality and precision.
2. **Enhanced Worker Safety :** By automating dangerous or physically demanding tasks, manufacturing robotics help to minimize workplace injuries. This reduction in human exposure to hazardous processes not only improves safety but also allows human workers to focus on more skilled and less risky tasks.

- 108.** Discuss two ways smart home devices contribute to energy savings.

**Ans :**

COMP 2008

1. **Automated Energy Management :** Smart home devices continuously monitor environmental conditions and adjust settings such as lighting and heating automatically. This real-time optimization prevents unnecessary energy consumption by tailoring operations to actual occupancy and usage patterns.
2. **Optimized Resource Use :** AI algorithms in smart homes analyze energy usage trends and predict future consumption needs. This predictive management ensures that energy is used efficiently, reducing wastage and leading to long-term savings on utility bills.

- 109.** Identify two specific applications of robotics in healthcare beyond surgery.

**Ans :**

MAIN 2022

1. **Rehabilitation Robots :** These robots provide guided exercises and therapeutic movements to help patients recover mobility after injuries or surgeries. Their ability to deliver precise, repeatable motion supports structured rehabilitation programs and accelerates the recovery process.
2. **Robotic Prosthetics :** Advanced prosthetic

limbs incorporate robotics to mimic natural movement, offering users enhanced control and functionality. These devices adapt to the user's motions and provide improved stability and dexterity, significantly improving quality of life.

- 110.** Describe two examples of how AI integration in robotics leads to improved operational efficiency.

**Ans :**

SQP 2025

1. **Autonomous Navigation in Warehouses :** AI-powered robots use sophisticated mapping and path-planning algorithms to navigate complex warehouse layouts. This enables them to efficiently transport and organize goods, reducing delays and optimizing overall workflow.
2. **Adaptive Decision-Making in Smart Mobility :** In transportation, AI integrates real-time traffic data to dynamically adjust vehicle routes and speeds. This adaptability minimizes travel time and improves resource management, leading to a more efficient and responsive mobility system.

## CASE BASED QUESTION

- 111.** Assistant robots are playing an increasingly important role in everyday life. For example, personal assistant robots (like robotic vacuum cleaners) and healthcare assistants help with household chores and provide specialized support. With reference to the above, mention two benefits of using assistant robots.

**Ans :**

1. **Improved Quality of Life :** Assistant robots help reduce the burden of daily tasks, enabling individuals to focus on more meaningful activities.
2. **Support in Labor-Limited Environments :** They provide essential assistance in settings where human labor is limited or needs augmentation, such as care for the elderly or disabled.

- 112.** Smart schools integrate modern technology to enhance the learning environment. For instance, interactive smart boards and AI-driven teaching assistants support personalized learning and

effective resource management. With reference to the above, mention two advantages of using smart schools.

**Ans :**

1. **Enhanced Engagement and Personalized Education :** Smart technologies tailor learning experiences to individual needs, increasing student participation and understanding.
2. **Efficient Resource Management :** Digital tools and automated scheduling contribute to better management of school resources and administrative tasks.

- 113.** Autonomous drones are increasingly utilized across various sectors. For example, drones in agriculture monitor crops and those used for delivery access remote or hard-to-reach areas. With reference to the above, mention two advantages of using autonomous drones.

**Ans :**

1. **Access to Remote or Hazardous Areas :** Drones can operate in environments that are difficult or unsafe for humans, ensuring continuous monitoring or delivery.
2. **Cost-Effective and Efficient Operations :** Their ability to cover large areas quickly makes them an economical option for tasks like surveillance, mapping, or delivery.

- 114.** Robotics in medicine and healthcare has brought revolutionary changes. For instance, surgical robots like the da Vinci Surgical System enable minimally invasive procedures. With reference to the above, mention two benefits of using robotic systems in healthcare.

**Ans :**

1. **Increased Precision and Reduced Recovery Times :** Robotic assistance in surgeries can lead to more precise operations, which in turn can minimize tissue damage and shorten patient recovery periods.
2. **Enhanced Access to Specialized Care :** Telepresence and remote operation capabilities allow expert medical care to reach patients in underserved or remote locations.

- 115.** Non-Axiomatic Reasoning Systems (NARS) are designed to function effectively under conditions of uncertainty and limited computational resources. For example, in smart homes and autonomous vehicles, NARS adapts to real-time changes by updating its reasoning based on incoming data.

With reference to the above, mention two benefits of using NARS in robotic systems.

**Ans :**

1. **Adaptability to Changing Conditions :** NARS can continuously adjust its reasoning in response to new or incomplete data, making it suitable for dynamic real-world environments.
2. **Efficient Use of Limited Resources :** Its design is optimized for systems with constrained computational power, allowing effective decision-making even in embedded applications.

- 116.** A large e-commerce warehouse wants to improve its sorting and packing process by reducing human error and increasing efficiency. Should they use traditional machines, robots, or AI-powered robotics? Why?

**Ans :**

They should use AI-powered warehouse robots because :

1. Traditional machines perform fixed operations and lack the flexibility needed for dynamic environments.
2. Warehouse robots (like Amazon's Kiva robots) can autonomously navigate, retrieve items, and minimize human error.
3. The integration of AI allows these robots to continuously optimize operations based on real-time data, ensuring peak efficiency.

- 117.** A company wants to introduce self-cleaning technology in office spaces, ensuring that rooms are cleaned efficiently without human intervention. What type of system should they implement?

**Ans :**

They should implement assistant robots such as robotic vacuum cleaners because :

1. Traditional cleaning machines require manual operation and lack adaptability.
2. Robotic vacuum cleaners (e.g., Roomba) autonomously navigate around obstacles and clean effectively.
3. These systems leverage smart sensors and AI to improve cleaning patterns and adjust to room layouts dynamically.

- 118.** A new residential complex is integrating smart home features for security and energy efficiency. Should they use traditional automation or AI-powered smart systems? Why?

**Ans :**

They should use AI-powered smart home systems because :

1. Traditional automation uses fixed timers and cannot adapt to unexpected changes in environment.
2. AI-powered systems (such as adaptive thermostats and security cameras) adjust automatically based on real-time inputs.
3. This approach not only boosts energy savings but also enhances the overall safety and responsiveness of the home environment.

- 119.** A university wants to implement AI-driven teaching assistants that provide personalized learning experiences. Should they use traditional software or AI-powered robotics? Why?

**Ans :**

They should use AI-powered educational assistants because :

1. Traditional software delivers fixed, one-size-fits-all content without personalization.
2. AI-driven assistants can analyze individual student performance and tailor feedback accordingly.
3. This personalization leads to improved engagement and can better address the diverse needs of students in real time.

- 120.** A city is experiencing severe traffic congestion and wants to implement a system to improve vehicle flow and safety. Should they use fixed traffic signals or AI-based smart mobility solutions? Why?

**Ans :**

They should use AI-based smart mobility solutions because :

1. Fixed traffic signals operate on predetermined schedules that cannot adapt to real-time congestion.
2. AI-powered traffic management systems analyze live data to adjust signals dynamically and efficiently.

This real-time responsiveness helps reduce congestion, improves safety, and optimizes traffic flow throughout the city.

- 121.** A car manufacturing company is deciding whether to use traditional robotic arms or AI-integrated robotic arms for vehicle assembly. Which option should they choose and why?

**Ans :**

They should choose AI-integrated robotic arms because :

1. Traditional robotic arms work on fixed programs and lack the flexibility to adjust during assembly variations.
2. AI-integrated arms can modify their actions based on sensor feedback to maintain precision and efficiency.

This integration results in higher quality assembly with reduced error rates and increased production speed.

- 122.** A logistics company wants to introduce aerial delivery for small packages in remote areas. Should they use manual drone control or autonomous drones? Why?

**Ans :**

They should use autonomous drones because :

1. Manual drone control requires constant human oversight, limiting scalability and efficiency.
2. Autonomous drones can independently navigate, avoid obstacles, and optimize delivery routes using AI.

This autonomy ensures consistent and reliable delivery even in challenging or remote environments.

- 123.** A hospital wants to introduce robotic surgery to enhance precision in complex procedures. Should they use traditional surgical tools or robotic-assisted systems? Why?

**Ans :**

They should use robotic-assisted surgical systems because :

1. Traditional surgical tools rely entirely on human skill, which can be limited by fatigue or variability.
2. Robotic systems (like the da Vinci Surgical System) provide enhanced precision and consistent performance.

These systems also offer real-time feedback and adjustments, ultimately improving patient outcomes and reducing recovery times.

- 124.** A hotel is considering deploying robotic waiters to improve service speed. Should they use traditional service methods or AI-powered robots? Why?

**Ans :**

They should use AI-powered robotic waiters because :

1. Traditional service methods can lead to inconsistent service speed and quality during peak times.
2. Robotic waiters can efficiently manage deliveries, handle customer requests, and navigate the service area autonomously.

This technology not only improves operational efficiency but also enhances the overall guest experience by ensuring timely service.

- 125.** A smart city initiative wants to improve street lighting efficiency based on real-time environmental conditions. Should they use fixed timers or AI-based lighting systems? Why?

Ans :

They should use AI-based lighting systems because :

1. Fixed timers operate on a predetermined schedule and cannot adjust to changing conditions such as traffic or weather.
2. AI-based systems can dynamically adjust brightness based on factors like pedestrian movement and ambient light.

This adaptability leads to significant energy savings and enhanced public safety by providing optimal lighting when and where it is needed.

# CHAPTER 2

## FROM ROBOTS TO COBOTS

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### SUMMARY

#### 1. MACHINE

A machine is a device that uses energy to perform a specific function or task. It typically follows a fixed set of operations once powered or triggered. Example : A washing machine cleans clothes when switched on; it does not adapt to new conditions without human intervention.

#### 2. ROBOT

A robot is a programmable machine designed to sense its environment, process information, and act based on instructions or algorithms. It can adjust its behavior based on sensor feedback, maintain certain speeds or parameters, and perform tasks with autonomy or semi-autonomy. Example : An automated vacuum cleaner (robotic vacuum) senses obstacles and changes its path accordingly.

#### 3. KEY DIFFERENCES

1. Adaptability : Robots continuously sense the environment and can adjust actions; simple machines operate with limited or no feedback.
2. Programming and Control : Robots have programmable controllers (microcontrollers/CPUs) that process inputs; machines often rely on mechanical or predetermined control.
3. Task Complexity : Robots handle complex, multi-step tasks with decision-making; machines usually handle simpler, single-purpose tasks.

#### 4. ILLUSTRATIONS

1. Machine Example : A ceiling fan spins at a set speed once switched on. It does not “sense” the room; it only responds to the switch.
2. Robot Example : An industrial robot arm can sense position, speed, and torque to carefully place components on a conveyor belt.

#### 5. COBOTS (COLLABORATIVE ROBOTS)

Cobots (Collaborative Robots) are robotic systems designed to work alongside humans in a shared workspace.

They feature advanced sensors and safety mechanisms to detect and respond to human presence and interactions.

#### 6. DIFFERENCE BETWEEN A ROBOT AND A COBOT

1. Interaction : Traditional robots often operate in isolation behind safety barriers. Cobots, by design, can collaborate and interact directly with human workers.
2. Safety Features : Cobots typically have force-limiting features, soft end-effectors, or advanced vision systems to ensure human safety.
3. Complexity of Tasks : Cobots focus on tasks requiring close human-robot synergy (e.g., assisting in precise assembly), while traditional robots often handle fully automated tasks (e.g., mass manufacturing).

#### 7. IMPORTANCE OF COBOTS

1. They enhance efficiency and productivity by combining human creativity and dexterity with robotic precision and endurance.
2. They reduce physical strain on human workers by handling repetitive or heavy tasks.
3. They offer flexibility on production lines, allowing quick changes to processes without extensive reprogramming or fencing.

#### 8. PROGRESS FROM ROBOTS TO COBOTS

1. Early Robots : Designed for repetitive, high-volume tasks with minimal adaptability, often requiring strict safety measures (cages or barriers).
2. Modern Collaborative Robots : Equipped with advanced sensors, machine vision, and AI algorithms to detect proximity to humans and adjust force or speed accordingly.

3. Future Trends : Increasingly intelligent cobots capable of understanding complex instructions, learning from human demonstrations, and ensuring enhanced safety for all.

## MULTIPLE CHOICE QUESTION

1. Which feature primarily distinguishes a robot from a simple machine?
- It relies entirely on human control
  - It does not require electrical energy
  - It can sense its surroundings and respond accordingly
  - It cannot be programmed

Ans :

MAIN 2025

- (c) It can sense its surroundings and respond accordingly

A defining characteristic of robots is their ability to sense environmental conditions and modify their actions. Unlike simple machines, which perform a fixed function, robots incorporate sensors and processing units. This allows them to perceive changes, adapt speeds or paths, and act intelligently according to programmed instructions.

2. Which of the following best describes a cobot?
- A robot designed for high-speed production away from humans
  - A machine with no autonomous features
  - A robot specifically designed to collaborate with humans in a shared space
  - An industrial robot that requires isolation from humans

Ans :

SQP 2021

- (c) A robot specifically designed to collaborate with humans in a shared space

Cobots (collaborative robots) are built with interactive features, enabling them to safely and efficiently work alongside human operators. They come equipped with sensors, force-limiting capabilities, and programmed responses that protect human coworkers. This is distinct from traditional robots, which typically work behind safety barriers to prevent collisions.

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3. Which of the following is NOT a characteristic of a cobot?
- Ability to detect human proximity
  - High force exertion without safeguards
  - Advanced safety mechanisms
  - Collaborative programming features

Ans :

COMP 2023

- (b) High force exertion without safeguards

Cobots are designed with safety in mind, often limiting force or using sensors to avoid harmful contact with humans. If a robot exerts high force without safeguards, it contradicts the foundational principle of collaborative robotics. Cobots must minimize injury risk through force-limiting or other safety features.

4. A robot that adjusts its speed when a person approaches is demonstrating which key concept?
- Fixed automation
  - Feedback control
  - Mechanical advantage
  - Passive operation

Ans :

MAIN 2024

- (b) Feedback control

Feedback control involves monitoring sensor inputs (e.g., proximity sensors) and modifying a robot's behavior in real time. If a robot slows down or changes course upon detecting a nearby person, it is using feedback control loops to ensure safe interaction and adapt based on environmental data.

5. In a factory setting, which device is most likely a simple machine rather than a robot?
- Automated guided vehicle
  - Conveyor belt
  - Pick-and-place robotic arm
  - Cobot assisting with assembly

Ans :

SQP 2013

- (b) Conveyor belt

A conveyor belt typically runs at a set speed, moving objects from one point to another without sensing or adapting to changes. It lacks sensors, decision-making capabilities, and reprogrammability. In contrast, robotic arms and cobots incorporate sensing and control loops to adapt to varying conditions.

6. What is the primary reason collaborative robots are gaining popularity?
- They replace all human workers fully
  - They can easily malfunction

- (c) They allow humans and robots to work side-by-side safely
- (d) They eliminate the need for programming

Ans :

COMP 2016

- (c) They allow humans and robots to work side-by-side safely

Collaborative robots (cobots) are designed with safety features that enable seamless coexistence with human coworkers on the same tasks. Their built-in sensors and force-limiting systems help prevent collisions or injuries, making processes more efficient and flexible. This unique human-robot synergy is a key factor driving cobot popularity.

7. A key element of a robot's autonomy is its ability to \_\_\_\_\_.
  - (a) operate only under direct human control
  - (b) sense, process information, and act independently
  - (c) function without electricity
  - (d) perform a single repetitive function with no variations

Ans :

MAIN 2015

- (b) sense, process information, and act independently

Autonomy in robots refers to their capacity to sense the environment, interpret the data, and make decisions independently based on programmed algorithms. This differs from simple mechanized or manual operations that cannot adapt. By continuously gathering and processing information, robots dynamically adjust their actions to meet objectives.

8. Which safety feature is commonly associated with cobots?
  - (a) High-speed motors for faster production
  - (b) Laser pointers for guiding humans
  - (c) Force sensors that limit excessive force upon contact
  - (d) Complete elimination of human input

Ans :

SQP 2019

- (c) Force sensors that limit excessive force upon contact

Cobots typically incorporate force-limiting sensors to detect when they come into contact with humans or objects unexpectedly. This feature immediately reduces force or halts movement to avoid injury. Such safety mechanisms allow humans and cobots to work collaboratively in close proximity without the need for heavy protective barriers.

9. One advantage of introducing cobots to an assembly line is \_\_\_\_\_.
  - (a) total removal of all human intervention
  - (b) guaranteed error-free production without human oversight
  - (c) enhanced collaboration leading to improved efficiency and less strain on workers
  - (d) higher operating speeds than standard industrial robots

- (c) enhanced collaboration leading to improved efficiency and less strain on workers

- (b) guaranteed error-free production without human oversight

- (c) enhanced collaboration leading to improved efficiency and less strain on workers

- (d) higher operating speeds than standard industrial robots

Ans :

COMP 2006

- (c) enhanced collaboration leading to improved efficiency and less strain on workers

Cobots share tasks with human operators, reducing fatigue for workers and improving overall throughput. By combining human flexibility and creativity with robotic precision and endurance, the production process becomes both more efficient and more ergonomic. This collaborative environment fosters innovation and continuous improvement on the assembly line.

10. Which of the following sensors is most crucial for cobots to detect human proximity?
  - (a) Temperature sensor
  - (b) Camera or vision sensor
  - (c) pH sensor
  - (d) Humidity sensor

- (a) Temperature sensor

- (b) Camera or vision sensor

- (c) pH sensor

- (d) Humidity sensor

Ans :

MAIN 2012

- (b) Camera or vision sensor

Vision sensors (cameras) or proximity sensors (like infrared or lidar) help cobots identify where humans are located in real time. By interpreting visual or distance-based data, a cobot can adjust its movements. Temperature or pH sensors are specialized to measure specific factors, not typically used for human proximity.

11. In a manufacturing plant, which scenario best illustrates a 'machine' rather than a 'robot'?
  - (a) A device automatically scanning barcodes and sorting packages
  - (b) A system adjusting its conveyor speed based on sensor input
  - (c) A drill press that runs at a fixed speed without feedback
  - (d) A vacuum guided by AI to avoid obstacles

- (a) A device automatically scanning barcodes and sorting packages

- (b) A system adjusting its conveyor speed based on sensor input

- (c) A drill press that runs at a fixed speed without feedback

- (d) A vacuum guided by AI to avoid obstacles

Ans :

SQP 2018

- (c) A drill press that runs at a fixed speed without feedback

A drill press that only runs at one speed with no feedback mechanism is a machine. It does not

adapt to real-time changes in environment or workload. Robots and advanced machines that scan barcodes, vary speeds, or navigate obstacles incorporate sensors and control algorithms, exemplifying robotic features.

- 12.** Which statement is true regarding robotic arms and cobots?
- Both can sense human interaction equally
  - Robotic arms generally operate behind fences; cobots operate safely alongside humans
  - Robotic arms are more cost-effective than cobots
  - Cobots always run at the same speed as robotic arms

**Ans :** COMP 2011

(b) Robotic arms generally operate behind fences; cobots operate safely alongside humans  
Traditional robotic arms often require safety fencing and restricted access to protect human operators from high-speed or forceful movements. Cobots, in contrast, are designed with advanced safety features allowing shared workspaces. They often have slower speeds or force-limited mechanisms, enabling safe, direct interaction with human coworkers.

- 13.** When a robotic system adjusts its grip based on object fragility, it is demonstrating what principle?
- Fixed operation
  - Variable power supply
  - Adaptive control
  - Passive sensing

**Ans :** MAIN 2009

(c) Adaptive control  
Adaptive control systems use sensor feedback to modify robotic behavior in real time. If a robot detects an object is fragile, it reduces grip force accordingly. This capacity for on-the-fly adjustment is central to robotics and particularly important in collaborative settings where safety and precision are essential.

- 14.** Cobots are especially beneficial in tasks that require \_\_\_\_\_.
- extremely high, unregulated force
  - zero human intervention
  - delicate human-robot interaction and joint effort
  - repetitive operations in hazardous areas with no humans present

**Ans :**

SQP 2014

(c) delicate human-robot interaction and joint effort

Cobots thrive in environments where humans and machines must share tasks, such as fine assembly or product customization. Their sensitive sensors and safety features enable them to handle delicate parts and cooperate with human movements. They're less suited for fully isolated, hazardous, or high-force operations typical of traditional robots.

- 15.** Which factor has most contributed to the transition from traditional robots to cobots?
- The desire to remove all humans from factories
  - The need for safer, more flexible human-robot interaction
  - Increasing cost of automation
  - Reduction in sensor technologies

**Ans :** COMP 2007

(b) The need for safer, more flexible human-robot interaction  
Evolving industrial and service demands require robots that can collaborate with human workers. This shift focuses on safety, adaptability, and user-friendliness. Cobots address these needs by integrating sensors and software that allow real-time interaction. Their flexibility and lower barriers to deployment encourage widespread industry adoption over traditional robots.

- 16.** One key advantage of employing cobots in small-scale workshops is \_\_\_\_\_.
- They require no technical knowledge at all
  - High initial costs and long return on investment
  - Their ability to be programmed and repurposed quickly
  - The impossibility of customizing their tasks

**Ans :** SQP 2017

(c) Their ability to be programmed and repurposed quickly

Cobots are relatively easy to program and can be swiftly adapted to different tasks. Their user-friendly interfaces, lightweight designs, and flexible safety features allow small businesses to shift from one function to another without extensive engineering. This quick repurposing capability reduces costs and increases workshop productivity.

17. Which of the following best shows how a cobot differs from a typical industrial robot?

(a) Ability to function on mechanical energy only  
 (b) Complete isolation from humans  
 (c) Built-in proximity sensors for safe, direct human interaction  
 (d) Dependence on high voltage supply

Ans :

MAIN 2010

(c) Built-in proximity sensors for safe, direct human interaction

Traditional industrial robots often lack real-time proximity sensing for safe collaboration, instead relying on physical barriers. Cobots, on the other hand, integrate proximity sensors and other safeguards (like force-limited joints) that enable them to work side by side with people. This user-friendly design is fundamental to collaborative robotics.

18. In the context of robotics, ‘sensing’ refers to \_\_\_\_\_.

(a) human observation of the robot  
 (b) the robot detecting and measuring environmental inputs  
 (c) storing large amounts of memory  
 (d) a machine operating at high speeds

Ans :

SQP 2008

(b) the robot detecting and measuring environmental inputs

Sensing in robotics involves using sensors (e.g., cameras, proximity, force) to collect data about the environment or the robot’s own state. This information is fed into a control system, where decisions are made. Without sensing, a device cannot autonomously adjust its actions based on dynamic real-world conditions.

19. Which of the following tasks is most suitable for a cobot rather than a simple machine?

(a) Lifting and lowering a warehouse gate uniformly  
 (b) Maintaining a constant speed for cooling fans  
 (c) Repetitive filling of identical bottles  
 (d) Assisting a human in precision assembly of delicate components

Ans :

COMP 2022

(d) Assisting a human in precision assembly of delicate components

Precision assembly alongside humans showcases a cobot’s strengths in safety, adaptability, and gentle handling. Simple machines cannot sense

or adapt to slight variations in positioning or pressure, whereas a cobot uses sensors and real-time control to cooperate with human input, ensuring accurate, damage-free assembly of fragile parts.

20. Which statement about simple machines is correct?

(a) They modify motions or force but lack autonomous feedback  
 (b) They have full autonomy like robots  
 (c) They are always powered by AI algorithms  
 (d) They require continuous reprogramming from humans

Ans :

MAIN 2006

(a) They modify motions or force but lack autonomous feedback

Simple machines (e.g., levers, pulleys, gears) transform or transmit energy and can simplify tasks but do not incorporate sensing or decision-making. Their function remains constant once set in motion. They lack the programmable feedback loops and active control systems that define autonomous robots and cobots.

21. A cobot’s ‘human in the loop’ design means \_\_\_\_\_.

(a) The cobot is operated remotely without physical interaction  
 (b) The human only observes but does not interact  
 (c) The cobot and human share tasks, actively cooperating in real-time  
 (d) The cobot cannot function without a fence

Ans :

SQP 2012

(c) The cobot and human share tasks, actively cooperating in real-time

“Human in the loop” highlights that human operators and the cobot work together in the same environment, often sharing work flows. The cobot relies on sensory and control strategies to coordinate with the human, who may provide real-time guidance, make adjustments, or perform tasks that complement the robot’s actions.

22. In terms of sensing, a robot differs from a machine primarily because it \_\_\_\_\_.

(a) is always smaller  
 (b) uses real-time feedback to make decisions  
 (c) has no mechanical parts  
 (d) cannot use electricity

Ans :

COMP 2018

(b) uses real-time feedback to make decisions  
Robots continuously gather data from their environment and utilize this feedback to adapt. In contrast, a typical machine performs a set function without evaluating changing conditions. This feedback loop allows robots to adjust speed, torque, or direction, making them versatile and safe in dynamic or unpredictable settings.

- 23.** An industrial robot used in a closed, guarded cell typically lacks \_\_\_\_\_.  
(a) Sensors for positioning  
(b) High-level safety features for direct human interaction  
(c) Ability to repeat tasks  
(d) Programming capability

**Ans :** MAIN 2011

(b) High-level safety features for direct human interaction  
Many traditional industrial robots operate with minimal built-in safety for human interaction, hence the need for a guarded cell. They might have sensors for positioning the end-effector but are not designed to slow down or stop upon detecting humans nearby. Cobots fill this gap by offering sophisticated safety mechanisms.

- 24.** Which of the following best explains why cobots are considered safer?  
(a) They work at extremely high speeds  
(b) They lack any moving joints  
(c) They incorporate force-limited joints and real-time sensing  
(d) They replace human involvement entirely

**Ans :** SQP 2013

(c) They incorporate force-limited joints and real-time sensing  
Safety is central to cobot design, achieved through force-limited actuators, proximity sensors, and intelligent control software. If a collision is imminent or occurs, the cobot slows or stops to minimize injury risk. Unlike traditional robots, cobots are specifically engineered to operate closely with humans without isolating barriers.

- 25.** A robot that “learns” from human demonstration to perform a task is likely using \_\_\_\_\_.  
(a) Manual override only  
(b) No sensors or feedback  
(c) Demonstration-based programming or imitation learning  
(d) Purely mechanical linkages

**Ans :** COMP 2016

(c) Demonstration-based programming or imitation learning  
Demonstration-based programming (or imitation learning) allows a robot or cobot to record human movements and replicate them. The robot “learns” the trajectory, force, and sequence of actions from direct human guidance or sensor data. This approach simplifies programming, especially for collaborative environments where tasks may require frequent adaptation.

- 26.** Cobots are increasingly found in small businesses because \_\_\_\_\_.  
(a) They require no investment  
(b) They are too large for big factories  
(c) Their flexibility and ease of programming make them cost-effective  
(d) They can only operate in labs

**Ans :** MAIN 2015

(c) Their flexibility and ease of programming make them cost-effective  
Small businesses benefit from cobots due to manageable upfront costs, quick setup, and user-friendly interfaces. Cobots can be reprogrammed for different tasks without extensive technical expertise, offering a fast return on investment. Their compact design and inherent safety measures also facilitate integration into smaller, existing workspaces.

- 27.** Which of the following is an example of a cobot application?  
(a) A sealed, high-speed welding station with zero human presence  
(b) A simple calculator on a desk  
(c) A collaborative arm assisting workers in precise component fitting  
(d) A manual screwdriver

**Ans :** SQP 2019

(c) A collaborative arm assisting workers in precise component fitting  
A collaborative arm that helps workers in fitting precise or delicate components demonstrates how cobots function. They combine human dexterity and judgment with robotic accuracy. High-speed welding in a sealed cell is typical of traditional industrial robots that keep people at a distance for safety and efficiency.

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**28.** In collaborative robotics, force-limiting technology helps \_\_\_\_\_.

- (a) the cobot to move faster than normal
- (b) the cobot to ignore feedback from sensors
- (c) in stopping the cobot or reducing speed when contact is detected
- (d) the cobot to operate without human supervision

**Ans :**

COMP 2025

(c) in stopping the cobot or reducing speed when contact is detected

Force-limiting technology ensures that if a cobot strikes or presses against a person or object, it immediately limits or stops movement. This quick response prevents injuries and safeguards the workspace. Such technology is fundamental for allowing humans and robots to share tasks closely without significant protective barriers.

**29.** In moving from robots to cobots, one significant change is the \_\_\_\_\_.

- (a) shift from any kind of sensing to no sensing
- (b) addition of advanced sensors and interaction-focused software
- (c) removal of user safety as a design factor
- (d) reduction in adaptive control mechanisms

**Ans :**

MAIN 2021

(b) addition of advanced sensors and interaction-focused software

Traditional industrial robots might have basic sensors for positioning, but cobots are equipped with more sophisticated perception systems (force, vision, proximity). They also incorporate software designed for real-time interaction with humans. These additions enable safe collaboration and more flexible task sharing, marking a clear progression from traditional robotics.

**30.** Which feature is least likely found in a cobot system?

- (a) Fencing or caging that bars human entry
- (b) Force sensors to detect collisions
- (c) Programming interfaces to train movements
- (d) Safety-rated speed control

**Ans :**

SQP 2023

(a) Fencing or caging that bars human entry

Unlike traditional robots often kept behind fences, cobots are built for direct human interaction. They feature force sensors, user-friendly programming methods, and speed controls to ensure safety. Consequently, it's uncommon for cobots to be

permanently caged away from humans, as their main advantage is safe, collaborative operation.

**31.** A homeowner uses a device in the laundry room that cleans clothes when switched on, following a fixed set of operations without any sensor feedback. Which category does this device belong to?

- (a) Machine
- (b) Robot
- (c) Cobot
- (d) Autonomous System

**Ans :**

COMP 2024

(a) Machine

This device operates on a fixed sequence when powered, using energy to complete its designated task. It lacks sensors and cannot adapt to its environment, distinguishing it from robots. Machines, like washing machines, rely solely on predetermined operations rather than sensor feedback or autonomous decision-making capabilities.

**32.** An industrial arm in a factory senses its position, speed, and torque to carefully place components on a conveyor belt. Which category best describes this device?

- (a) Machine
- (b) Robot
- (c) Cobot
- (d) Simple Device

**Ans :**

MAIN 2009

(b) Robot

This industrial robot arm is programmable and designed to sense its environment using sensors that monitor position, speed, and torque. Its ability to adjust its actions based on real-time feedback distinguishes it from simple machines. It processes sensor information to perform complex, multi-step tasks autonomously with precision.

**33.** A manufacturing facility deploys a robotic system that works safely alongside human workers by detecting their presence and adjusting its speed. Which type of system is this?

- (a) Machine
- (b) Traditional Robot
- (c) Cobot
- (d) Autonomous Drone

**Ans :**

SQP 2014

(c) Cobot

This collaborative robot, or cobot, is designed to work safely alongside human workers. Equipped with advanced sensors and safety mechanisms, it detects human presence and adjusts its operational speed accordingly. Cobots enhance productivity and reduce physical strain by combining human dexterity with robotic precision in shared work spaces, ensuring overall efficiency.

- 34.** A building uses a ceiling fan for ventilation. The fan spins at a fixed speed when switched on and does not respond to room conditions. What best describes this device?
- (a) Machine
  - (b) Robot
  - (c) Cobot
  - (d) Autonomous System

**Ans :**

COMP 2007

(a) Machine  
The ceiling fan operates as a machine because it performs a specific, unchanging function—a constant rotational speed—once activated. It lacks sensors or programmable control, meaning it does not adapt its operations based on environmental conditions. This fixed, predetermined operation differentiates it from robots, which utilize sensor feedback for adaptive behavior, effectively.

- 35.** A tech company develops an automated vacuum cleaner that senses obstacles and adjusts its path while cleaning floors. Which category does this device belong to?
- (a) Machine
  - (b) Robot
  - (c) Cobot
  - (d) Autonomous Drone

**Ans :**

MAIN 2017

(b) Robot  
This device, an automated vacuum cleaner, qualifies as a robot because it senses obstacles and adjusts its path based on sensor feedback. Unlike simple machines with fixed operations, this robot processes environmental data to adapt its behavior, demonstrating the advanced programming and control inherent in robotic systems, ensuring superior autonomous performance.

- 36.** A manufacturing company seeks to automate heavy lifting tasks while ensuring safe human-robot collaboration. Which solution fits this scenario best?
- (a) Traditional Robots

- (b) Cobots
- (c) Simple Machines
- (d) Autonomous Drones

**Ans :**

SQP 2010

(b) Cobots  
Cobots, or collaborative robots, are engineered to work safely alongside human workers. They combine robotic precision with human adaptability, reducing physical strain during repetitive tasks. Their advanced sensors and force-limiting features ensure safe interactions in shared work spaces, making them ideal for manufacturing processes requiring human-robot collaboration and dynamic task adjustments.

- 37.** In a manufacturing plant, an automated device continuously senses environmental data and adjusts its actions to perform complex assembly tasks. Which category best describes this system?
- (a) Machine
  - (b) Robot
  - (c) Cobot
  - (d) None of These

**Ans :**

COMP 2008

(b) Robot  
This automated device qualifies as a robot due to its continuous sensing of environmental data and adaptive response. Unlike simple machines, it processes information through programmable controllers to execute complex, multi-step tasks. Its real-time decision-making capability clearly distinguishes it from fixed-operation machines, which cannot adjust behavior based on sensor input.

- 38.** On a production line, a device stirs mixtures using fixed settings without any feedback mechanism. Which category does this device belong to?
- (a) Machine
  - (b) Robot
  - (c) Cobot
  - (d) Autonomous System

**Ans :**

SQP 2022

(a) Machine  
This production line device is a machine because it performs a specific, unchanging function without sensing or adapting to feedback. Its operation relies solely on fixed settings rather than dynamic input processing. This absence of adaptability distinguishes it from robots and cobots, which modify behavior based on sensor data, clearly.

- 39.** A robotics lab compares an industrial robot arm and a ceiling fan to illustrate differences in adaptability and control. Which statement best summarizes their difference?

(a) Both are equally adaptable.  
 (b) The robot arm senses and adjusts, while the ceiling fan operates on fixed settings.  
 (c) The ceiling fan adapts based on speed.  
 (d) Both have programmable controllers.

Ans :

MAIN 2024

(b) The robot arm senses and adjusts, while the ceiling fan operates on fixed settings.

The industrial robot arm senses its environment and adjusts operations based on sensor feedback, demonstrating adaptability and programmable control. In contrast, the ceiling fan operates on fixed settings without any feedback mechanism, classifying it as a simple machine. This difference highlights the dynamic capabilities of robots compared to basic, unchanging machines.

- 40.** A smart home system uses an AI framework to manage unpredictable conditions with incomplete data and limited resources. Which framework is best suited for this application?

(a) Fixed Axiomatic Systems  
 (b) Non-Axiomatic Reasoning System (NARS)  
 (c) Traditional Robotic Control  
 (d) Basic Machine Programming

Ans :

SQP 2023

(b) Non-Axiomatic Reasoning System (NARS)

The Non-Axiomatic Reasoning System (NARS) is ideal because it adapts to unpredictable real-world conditions using limited data and computational resources. Unlike fixed axiomatic systems, NARS learns from experience and adjusts reasoning dynamically, making it highly effective for smart home applications that require real-time decision-making under uncertainty and incomplete information, efficiently.

- 41.** Which statement is correct regarding the difference between a machine and a robot?

(a) A machine can modify its speed based on sensor input, but a robot cannot.  
 (b) A robot requires no electrical or computational components.  
 (c) A machine and a robot both lack feedback control.  
 (d) A robot is generally capable of sensing and decision-making, unlike a simple machine.

Ans :

COMP 2021

(d) A robot is generally capable of sensing and decision-making, unlike a simple machine.

Robots integrate sensors and can adapt decisions in real-time, while simple machines operate in a fixed manner without feedback loops. Thus, the correct statement highlights that robots generally possess sensing and decision-making capabilities, differentiating them from basic mechanical or electrical machines that lack such adaptive functionalities.

- 42.** Which of the following statements is correct about cobots?

(a) Cobots are designed to work strictly in isolation from humans.  
 (b) Cobots cannot be reprogrammed for new tasks.  
 (c) Cobots are specifically built for safe human-robot collaboration.  
 (d) Cobots eliminate all sensor usage for efficiency.

Ans :

MAIN 2025

(c) Cobots are specifically built for safe human-robot collaboration.

Cobots are defined by their capacity for close, safe collaboration with humans, using built-in sensors and safety features. They are not designed for isolated operation, and they rely heavily on sensors to ensure safe and effective teamwork. Hence, statement (c) accurately reflects the nature of cobots.

- 43.** Choose the correct statement about force-limiting in collaborative robots.

(a) It prevents the robot from sensing human proximity.  
 (b) It ensures that in a collision, the robot's force is controlled to avoid harm.  
 (c) It is only used in traditional industrial robots.  
 (d) It automatically fences off the robot's area.

Ans :

SQP 2019

(b) It ensures that in a collision, the robot's force is controlled to avoid harm.

Force-limiting technology is central to collaborative robots, restricting the potential force exerted if contact occurs. This reduces injury risk, as the cobot either slows or halts upon sensing an unexpected collision. Traditional industrial robots typically lack force-limiting, relying on physical barriers instead of direct human contact management.

- 44.** Identify the correct statement about modern trends in robotics.
- (a) Robots are moving away from any sensing to reduce costs.
  - (b) Cobots represent a shift toward safer, more interactive human-machine collaboration.
  - (c) Traditional robots are being replaced by stationary machines with no programming.
  - (d) Robotics is declining in industrial applications.

**Ans :**

COMP 2019

(b) Cobots represent a shift toward safer, more interactive human-machine collaboration.

The most prominent trend in robotics is the move toward collaborative systems—cobots—which emphasize safety and user-friendly interaction. Advances in sensor and control technologies are enabling flexible, shared work spaces. This approach does not signify a decline in robotics but rather an evolution to accommodate diverse, human-centric tasks.

- 45.** Which statement about traditional industrial robots is correct?
- (a) They are typically designed for close human interaction.
  - (b) They can always sense and avoid human workers in real time.
  - (c) They commonly require protective cages to ensure safety.
  - (d) They never require programming or control software.

**Ans :**

MAIN 2015

(c) They commonly require protective cages to ensure safety.

Traditional industrial robots operate at high speed and are often unaware of human proximity. To prevent accidents, they're usually placed in protective cages or behind safety barriers. Although they do have programming and control software, they lack the advanced, force-limiting features found in collaborative robot systems.

- 46.** Which of the following correctly defines a cobot's primary benefit?
- (a) Ability to perform delicate tasks in sync with humans safely
  - (b) Elimination of the need for human workers
  - (c) Reduced safety due to high speed
  - (d) Exclusively operating in remote, hazardous areas

**Ans :**

SQP 2016

(a) Ability to perform delicate tasks in sync with humans safely

Cobots shine in applications requiring both dexterity and human oversight—delicate, detail-oriented tasks where a worker's input and the robot's precision complement each other. Their built-in safety measures prevent injury and allow direct, synchronized work with humans, making them ideal for assembly, packaging, and various collaborative processes.

- 47.** Select the correct statement about sensing in robots vs. machines.

- (a) Machines are more likely to have advanced vision systems than robots.
- (b) Robots and machines are identical in sensing and adaptation.
- (c) Robots depend on sensors for feedback control; simple machines generally do not.
- (d) Machines always use advanced AI algorithms for decision-making.

**Ans :**

COMP 2013

(c) Robots depend on sensors for feedback control; simple machines generally do not.

The defining feature of robotics is the reliance on sensor data to adapt tasks and operate autonomously or semi-autonomously. Simple machines, in contrast, typically carry out single-function processes without integrating sensor-driven feedback loops. Therefore, the correct statement highlights the critical feedback role in robotic systems.

- 48.** Identify the correct statement about the evolution from robots to cobots.

- (a) Robots already had full human-robot collaboration from the start.
- (b) Cobots remove all forms of programming from robotics.
- (c) The evolution emphasizes better human-robot interaction and built-in safety features.
- (d) Traditional robots use more sensors than cobots.

**Ans :**

MAIN 2011

(c) The evolution emphasizes better human-robot interaction and built-in safety features.

The movement from traditional robots to cobots focuses on enabling closer, safer interaction with human operators. Collaborative robots integrate advanced sensing technology, improved programming interfaces, and safety protocols to prevent injuries, making them significantly

different from the cage-bound, high-speed industrial robots of previous generations.

49. Which statement correctly describes a simple machine's functionality?
- Simple machines function autonomously with sensor feedback.
  - Simple machines require continuous sensor updates to alter operations.
  - Simple machines can alter their tasks based on AI algorithms.
  - Simple machines have a preset mechanism and do not rely on dynamic feedback.

Ans :

SQP 2018

(d) Simple machines have a preset mechanism and do not rely on dynamic feedback. Simple machines, like levers, pulleys, or fixed-speed motors, perform their function based on unchanging mechanical principles. They do not actively adapt to real-time input or run AI algorithms. Their operation is straightforward, in contrast to robotic systems that employ sensor data to adjust tasks on-the-fly.

50. Which statement accurately portrays collaborative robots (cobots)?
- They remain static and cannot be redeployed to new tasks.
  - They rely on manual-only operations with no automation.
  - They enhance efficiency by working alongside humans with shared tasks.
  - They pose the same safety risks as high-speed industrial robots.

Ans :

COMP 2012

(c) They enhance efficiency by working alongside humans with shared tasks. Cobots offer significant benefits by cooperating directly with human operators. Their integrated sensing, user-friendly software, and force-limiting capabilities facilitate shared tasks without strict isolation barriers. This collaboration improves productivity and workplace ergonomics, making them valuable in diverse industries, from manufacturing to laboratories and small businesses.

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## ASSERTION AND REASON

51. **Assertion (A)** : A cobot can work safely with humans even without physical barriers.

**Reason (R)** : Cobots integrate sensors and force-limiting technologies to detect and adapt to human presence.

- Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- Assertion is correct, but Reason is incorrect.
- Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. The statement and reason both are correct, and the reason directly explains why a cobot can safely operate around humans. Cobots rely on sensors to monitor proximity and force-limiting mechanisms to avoid injuring humans. These features eliminate the need for heavy barriers common with traditional robots.

52. **Assertion (A)** : Traditional industrial robots often outpace cobots in terms of sheer speed and payload capacity.

**Reason (R)** : Cobots are designed with built-in safety measures that usually limit their speed and force to protect humans.

- Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- Assertion is correct, but Reason is incorrect.
- Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are true, and the reason directly explains why cobots usually have lower speeds and payloads. Traditional robots can be faster and stronger because they operate in segregated zones without the need for collision safety. Cobots' inherent safety features necessitate speed and force limitations for human collaboration.

**53. Assertion (A) :** Simple machines can be reclassified as cobots if they operate near humans.

**Reason (R) :** Cobots require interactive features like sensing and force control to ensure safety, which simple machines typically lack.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because proximity to humans alone doesn't make a device a cobot. The reason is correct : cobots mandate advanced sensing, feedback systems, and safety protocols. Simple machines operating near humans do not automatically gain these features, so they cannot be reclassified as cobots without major modifications.

**54. Assertion (A) :** Robots can perform complex tasks even under changing conditions.

**Reason (R) :** Robots rely on sensors and feedback loops to detect deviations and adjust operations accordingly.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. The assertion and reason are both correct, and the reason logically explains the assertion. Robots equipped with sensors and real-time feedback can adapt to environmental fluctuations (e.g., different object positions or variations in material). This enables them to handle complex tasks that simple machines cannot address dynamically.

**55. Assertion (A) :** A robot that cannot sense or adapt to its environment is still considered fully autonomous.

**Reason (R) :** Autonomy in robotics includes the ability to perceive surroundings and make decisions independently.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because autonomy requires environmental perception and adaptive decision-making. The reason is correct : a fully autonomous robot must sense, interpret, and act on real-time data. Without sensing or adaptation, it remains a programmed machine performing predetermined tasks without genuine autonomy.

**56. Assertion (A) :** Cobots are replacing all forms of machines in every industry.

**Reason (R) :** Cobots are safer than traditional industrial robots and simple machines in close human interaction.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(c) Assertion is correct, but Reason is incorrect. The assertion is incorrect because cobots are not replacing all machines across all sectors; some applications still demand high-speed, isolated robots or simple, cost-effective machines. The reason, however, is correct—cobots do offer enhanced safety for collaborative tasks, but this does not imply universal replacement.

**57. Assertion (A) :** Even a basic electric fan can be called a robot if it rotates automatically when switched on.

**Reason (R) :** Robots not only operate automatically but also use feedback to adapt to conditions or tasks.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect; an electric fan lacks sensing or adaptive control, so it's not a robot. The reason is correct : feedback-based adaptation is essential to robotic systems. Simply being powered and moving automatically does not qualify a device as a robot without sensing or decision-making capabilities.

- 58. Assertion (A) :** Cobots often have simpler end-of-arm tooling compared to traditional industrial robots.

**Reason (R) :** Cobots emphasize flexibility and safety over extremely high precision or heavy payload tasks in many scenarios.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both the assertion and the reason are correct, and the reason explains why cobots may use simpler or softer end-effectors—ensuring safe interaction and versatility. Traditional robots often require complex, rigid tooling to handle heavier loads at high speed. Cobots typically balance moderate precision and payload with safe human collaboration.

- 59. Assertion (A) :** A robotic device that can lift heavy loads quickly usually has extensive safety sensors for human interaction.

**Reason (R) :** High load capacity robots are typically used in fenced or isolated areas, reducing the need for advanced collision avoidance.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because high-load, high-speed robots are generally confined to safety

cages, not outfitted with comprehensive human-collaboration sensors. The reason is correct : industrial robots capable of heavy payloads are often deployed in closed cells to protect workers, making advanced collision avoidance less necessary.

- 60. Assertion (A) :** The transition from robots to cobots shows a trend towards safer and more interactive systems.

**Reason (R) :** Cobots integrate sensor-based safety features and user-friendly interfaces for direct human collaboration.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both the assertion and the reason are correct, and the reason accurately explains why newer systems are more interactive and safer. The shift to collaborative robotics is driven by the demand for human-robot teamwork. Sensor-based safety and intuitive programming empower cobots to operate near human counterparts effectively.

## STATEMENT BASED QUESTIONS

- 61.** Consider the following statements about the definitions of a machine and a robot :

1. A machine is a device that uses energy to perform a specific function or task by following a fixed set of operations once powered or triggered.
  2. A robot is a programmable machine designed to sense its environment, process information, and act based on instructions or algorithms, adjusting its behavior with sensor feedback.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

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The material clearly defines a machine as a device that performs tasks following fixed operations, while a robot is defined as a programmable machine that senses, processes, and acts based on feedback.

**62.** Consider the following statements regarding adaptability :

1. Robots continuously sense their environment and can adjust their actions based on sensor feedback.
  2. Simple machines operate with limited or no feedback and do not adapt to changing conditions without human intervention.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.  
Robots are designed to be adaptive by processing sensor inputs and modifying behavior, while simple machines follow predetermined operations without adapting to new conditions.

**63.** Consider the following statements regarding programming and control :

1. Robots have programmable controllers (such as microcontrollers or CPUs) that process sensor inputs and adjust operations accordingly.
  2. Simple machines generally rely on mechanical or predetermined control without the ability to process sensor feedback.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.  
Robots incorporate programmable control to handle sensor data and adjust actions, while simple machines operate based on fixed, predetermined control without real-time processing.

**64.** Consider the following statements about task complexity :

1. Robots are capable of handling complex, multi-step tasks that require decision-making and adaptive behavior.
2. Simple machines typically perform simpler, single-purpose tasks without the need for

decision-making.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

Robots are designed for complex tasks requiring adaptability and decision-making, whereas simple machines execute straightforward, repetitive functions.

**65.** Consider the following illustrative examples :

1. A ceiling fan, which spins at a set speed when switched on, is an example of a simple machine that does not sense its environment.
  2. An industrial robot arm that senses position, speed, and torque to carefully place components on a conveyor belt is an example of a robot.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

The ceiling fan is a simple machine operating on a fixed setting, while the industrial robot arm represents a robot that adapts its behavior based on sensor feedback.

**66.** Consider the following statements about cobots (collaborative robots) :

1. Cobots are designed to work alongside humans in a shared workspace and are equipped with advanced sensors and safety mechanisms.
  2. Traditional robots typically operate in isolation behind safety barriers, while cobots interact directly with human workers.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

The material explains that cobots are specifically designed for safe collaboration with humans, whereas traditional robots are usually isolated for safety reasons.

**67.** Consider the following statements regarding safety features :

1. Cobots typically include force-limiting features, soft end-effectors, and advanced vision systems to ensure human safety.
  2. Traditional robots generally lack these advanced safety features and rely on physical barriers for safe operation.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

Cobots incorporate inherent safety features that allow direct human interaction, while traditional robots are usually kept behind safety barriers due to the absence of such features.

**68.** Consider the following statements about the importance of cobots :

1. Cobots enhance efficiency and productivity by combining human creativity and dexterity with robotic precision and endurance.
  2. Cobots reduce physical strain on human workers by taking over repetitive or heavy tasks and offer production flexibility with minimal reprogramming.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

The material emphasizes that cobots improve productivity by leveraging the strengths of both humans and robots, and they help reduce the physical burden on human workers while offering flexibility in production lines.

**69.** Consider the following statements about the progress from traditional robots to cobots :

1. Early robots were designed for repetitive, high-volume tasks with minimal adaptability and often required strict safety measures (e.g., cages or barriers).
  2. Modern collaborative robots are equipped with advanced sensors, machine vision, and AI algorithms that allow them to safely work alongside humans and adjust their operations based on human presence.
- (a) Only statement 1 is correct.

- (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

The material describes the evolution from early robots that operated in isolation to modern cobots that incorporate advanced technology for safe human-robot collaboration.

**70.** Consider the following statements regarding future trends in robotics and cobots :

1. Future cobots are expected to become increasingly intelligent, capable of understanding complex instructions, learning from human demonstrations, and further enhancing safety during interactions.
  2. Future trends suggest that robots will continue to operate solely on fixed, predetermined control without any adaptive or learning capabilities.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

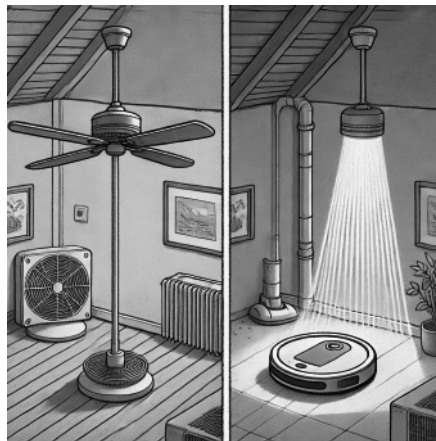
**Ans :**

(a) Only statement 1 is correct.

The material points to future cobots that will incorporate greater intelligence and adaptability, while statement 2 contradicts this trend by implying no further evolution in adaptability or learning, which is not supported by the text.

## PICTURE BASED QUESTIONS

**71.** Look at the given images :



Which of the following statements is correct?

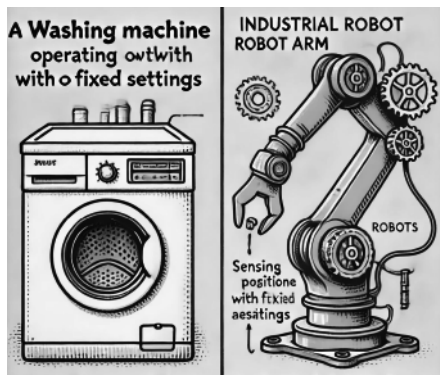
- (a) Both are machines, but only the vacuum cleaner is a robot.
- (b) Both are robots because they perform tasks.
- (c) The fan is a robot because it moves.
- (d) Neither is a machine.

Ans :

(a) Both are machines, but only the vacuum cleaner is a robot.

A machine performs a set function when powered (e.g., a fan spins at a fixed speed). A robot senses the environment and adjusts its actions (e.g., a vacuum cleaner avoids obstacles). Thus, the fan is a simple machine, while the vacuum cleaner is a robot.

72. Look at the given images :



Which statement is correct?

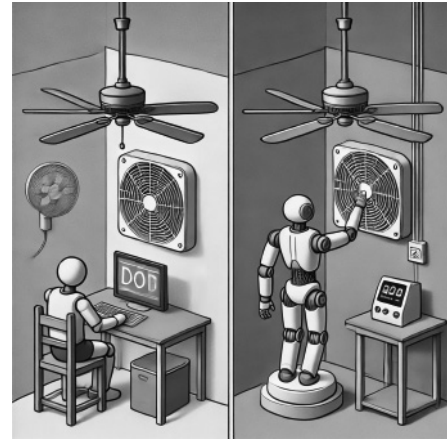
- (a) Both are robots.
- (b) The washing machine is a robot, but the industrial robot is not.
- (c) The washing machine is a machine, while the industrial arm is a robot.
- (d) Neither are machines.

Ans :

(c) The washing machine is a machine, while the industrial arm is a robot.

Machines follow set operations without adaptability (e.g., washing machines). Robots can sense, process, and adjust tasks dynamically (e.g., industrial arms adjusting placement based on sensor feedback).

73. Observe the two images :



Which feature differentiates the cobot from the fan?

- (a) The cobot senses and adapts; the fan does not.
- (b) Both respond to human actions equally.
- (c) The fan is more advanced because it moves faster.
- (d) The cobot cannot interact with humans.

Ans :

(a) The cobot senses and adapts; the fan does not.

A cobot is designed to collaborate with humans, using sensors to adjust speed and force. A ceiling fan is a simple machine that only follows a fixed function without adaptation.

74. Look at the given images :



What do both have in common?

- (a) They both need manual control.
- (b) They both sense, process, and adapt to the environment.
- (c) They are both simple machines.
- (d) Neither can function without human intervention.

Ans :

(b) They both sense, process, and adapt to the environment.

Both the robotic vacuum and the autonomous drone use sensors and AI to make decisions, adjusting their actions based on real-time feedback, unlike simple machines that follow fixed operations.

## TWO MARKS QUESTIONS

75. Define a simple machine. Give one example.

Ans :

MAIN 2025

A simple machine is a device that makes work easier by magnifying or redirecting force without complex feedback mechanisms. Examples include a lever, pulley, or wheel and axle. They operate on basic mechanical principles and do not adapt to changing conditions.

76. What is a robot? Mention one key component.

Ans :

SQP 2024

A robot is a programmable device capable of sensing, decision-making, and performing tasks. One key component is the microcontroller or processor, which processes sensor data and controls actuators in real time.

77. Why are sensors crucial for robots?

Ans :

COMP 2023

Sensors provide robots with real-time data about their environment (e.g., distance, color, force). This information allows them to adapt actions, avoid collisions, and perform tasks accurately, forming the foundation of robotic autonomy.

78. State one fundamental difference between a machine and a robot.

Ans :

MAIN 2021

A machine typically performs a fixed action once activated. A robot, however, uses sensor feedback and programming to modify its behavior, making decisions or altering parameters based on its surroundings.

79. What are cobots?

Ans :

SQP 2013

Cobots, or collaborative robots, are designed to safely work alongside humans in shared environments. Equipped with sensors and safety features, they can sense human proximity, limit force, and perform cooperative tasks with minimal risk.

80. How do cobots ensure safety during operation?

Ans :

COMP 2016

Cobots often integrate force-limiting actuators, proximity sensors, and advanced control algorithms. These features help them detect contact or close human presence, immediately stopping or reducing speed to avoid harm.

81. Give one reason why cobots are increasingly popular in small businesses.

Ans :

MAIN 2015

Cobots are user-friendly and relatively easy to program, making them accessible for small-scale operations. They can handle multiple tasks efficiently without heavy infrastructure changes or fencing, offering quick return on investment.

82. Mention one advantage of having a cobot over a traditional industrial robot.

Ans :

SQP 2019

Cobots enable direct, safe interaction with human workers, facilitating cooperative tasks. This reduces the need for costly safety barriers and allows more flexible production layouts and rapid task switching.

83. Define “feedback control” in the context of robotics.

Ans :

COMP 2006

Feedback control refers to the use of sensor data to compare actual performance with desired outcomes. Deviations trigger adjustments in actuator movements, enabling robots to dynamically adapt to changes or errors.

84. What does ‘human in the loop’ imply for cobot usage?

Ans :

MAIN 2012

It implies that humans and cobots collaborate in real time, with humans directly guiding, supervising, or contributing to a task. The cobot reacts to human inputs, ensuring synergy and shared responsibility.

85. Give an example of a real-world cobot application.

Ans : SQP 2018

In automotive assembly, a cobot might assist workers by carefully placing components while the human operator handles complex alignment tasks. This partnership maintains safety, speeds up production, and reduces repetitive strain.

86. What is one key safety feature used in collaborative robotics?

Ans : COMP 2011

Force-limiting is a common safety feature. If a collision occurs, the robot's motors automatically reduce torque or shut down, minimizing the force exerted on the human or object.

87. Explain how a robot can adapt to varying object shapes.

Ans : MAIN 2009

A robot can use sensors like cameras or 3D scanners to detect an object's dimensions. The data is processed in real time, adjusting the robot's grip or movement path to accommodate size or shape variations.

88. What is the role of artificial intelligence in cobots?

Ans : SQP 2014

AI allows cobots to recognize patterns, interpret visual data, and make predictive adjustments. By learning from past experiences or demonstrations, cobots can optimize tasks and improve their interactive abilities.

89. What distinguishes cobots from standard automated machinery?

Ans : COMP 2007

Cobots use advanced sensing and control to safely collaborate with humans rather than operating alone. They prioritize safety, adaptability, and ease of programming, whereas standard machinery often lacks real-time interaction features.

90. How does sensor fusion improve robotic performance?

Ans : MAIN 2017

Sensor fusion combines data from multiple sources (e.g., vision, force, proximity) to create a comprehensive environment model. This leads to more accurate decisions, smoother motion control, and enhanced safety.

91. Give one example of how robots sense their environment.

Ans : SQP 2010

Robots may use an ultrasonic sensor to measure distances by sending out sound pulses and timing their echo. This helps detect obstacles, ensuring the robot can navigate or avoid collisions effectively.

92. Why might a cobot use softer end-effectors?

Ans : COMP 2008

Softer or compliant end-effectors reduce the risk of damaging delicate objects or injuring humans. They provide a cushion and adapt to shapes, making them well-suited for tasks requiring gentle handling.

93. Mention one benefit of having a fully automated robot cell.

Ans : MAIN 2022

It can achieve high-volume, repetitive tasks at maximum speed and precision, minimizing human error. This is particularly useful in large-scale industrial settings demanding consistent throughput.

94. Explain how cobots help in ergonomics.

Ans : SQP 2025

Cobots can take over physically strenuous or repetitive tasks, reducing worker fatigue and risk of musculoskeletal injuries. Humans can then focus on more intricate or cognitively demanding activities, improving overall workplace ergonomics.

## THREE MARKS QUESTIONS

95. Differentiate between a machine and a robot with an example each.

Ans : COMP 2025

- Machine : Performs a defined task based on mechanical design; it does not adapt. Example : A hand-operated water pump.
- Robot : Senses, processes data, and acts autonomously or semi-autonomously. Example : A robotic vacuum that detects obstacles and changes path accordingly.

- 96.** Explain why feedback control is integral to robotics.

**Ans :**

MAIN 2021

Robots use sensor data to monitor actions in real time, comparing actual performance with the desired outcome. If there is a discrepancy, the controller adjusts actuator inputs. This closed-loop feedback ensures precision, adaptability to changing environments, and robust performance, differentiating robots from purely mechanical devices.

- 97.** Describe the principle of force-limiting in cobots.

**Ans :**

SQP 2023

Force-limiting systems measure the torque or force exerted by the robot's joints. If the force exceeds a safe threshold—indicating contact with a person or object—the cobot automatically reduces speed or stops. This ensures minimal injury risk, allowing human-robot interaction without extensive physical barriers.

- 98.** Outline two key benefits of deploying cobots in a manufacturing setup.

**Ans :**

COMP 2021

1. **Safe Collaboration :** Cobots can work closely with humans, improving workflow synergy and reducing the need for safety cages.
2. **Flexibility :** They are easy to program and redeploy, enabling quick adjustments in production lines for small-batch or customized manufacturing tasks.

- 99.** Discuss how cobots improve productivity without replacing human workers entirely.

**Ans :**

MAIN 2018

Cobots handle repetitive or physically demanding tasks, relieving workers who can then focus on high-value tasks such as quality checks or complex decision-making. This division of labor enhances overall productivity, as humans and robots each contribute their strengths—human creativity and dexterity paired with robotic consistency and endurance.

- 100.** Explain how sensory data enhances a robot's decision-making.

**Ans :**

SQP 2011

Sensory data (e.g., distance from obstacles, orientation of parts, or force applied) feeds into a control algorithm. The robot's "brain" interprets

these inputs and adjusts actuator commands—changing speed, path, or grip. This real-time loop boosts accuracy, adaptability, and safety, ensuring that the robot responds appropriately to environmental changes.

- 101.** Why might a small-scale workshop invest in a cobot rather than a traditional robot?

**Ans :**

COMP 2009

Cobots are simpler to program, require less floor space, and need fewer safety enclosures. They can be repurposed quickly for diverse tasks, offering a cost-effective solution with minimal disruption. Traditional robots might be overpowered, more expensive, or less flexible, demanding extensive setup and dedicated operation areas.

- 102.** Illustrate a scenario where a cobot's safety features prevent an accident.

**Ans :**

MAIN 2014

Imagine a worker placing delicate components on a shared workspace. If the worker's hand accidentally enters the cobot's path, the cobot's proximity sensors detect this incursion. Instantly, force-limiting actuators slow or stop the arm, avoiding collision and preventing potential injury or product damage.

- 103.** Describe how programming interfaces for cobots differ from traditional robot programming.

**Ans :**

SQP 2007

Cobot interfaces often utilize drag-and-drop or demonstration-based learning methods. Workers can guide the arm manually, and the cobot "records" the motions. Traditional robots often require specialized coding skills, proprietary software, or offline programming. This ease-of-use lowers training requirements and speeds up deployment for cobots.

- 104.** Explain the term 'human in the loop' with an example of cobot utilization.

**Ans :**

COMP 2017

A human operator guides the cobot through complex assembly tasks, adjusting component orientation while the cobot precisely bolts or fastens parts. Continuous input from the worker (verbal commands or manual guidance) complements the cobot's automated precision, forming a collaborative workflow that leverages both human skill and robotic consistency.

- 105.** How do safety regulations influence the design of cobots?

Ans :

MAIN 2010

Regulatory standards mandate features like force sensing, emergency stops, and risk assessments. To comply, cobot manufacturers integrate hardware and software redundancies, limiting maximum speeds and end-effector force. This ensures cobots meet the strict legal criteria necessary for shared work environments, promoting worker well-being and trust in automation.

- 106.** Compare the application scope of cobots and traditional industrial robots.

Ans :

SQP 2008

Traditional robots excel at large-scale, repetitive tasks that demand speed or high payload handling, typically in fenced, automated lines. Cobots, meanwhile, fit lower-volume, high-mix production or environments where human dexterity and oversight are beneficial. They are also preferred when frequent task changes and direct human-robot cooperation are required.

- 107.** Highlight two ways AI can enhance cobot functionalities.

Ans :

COMP 2022

1. Computer Vision : AI-driven vision helps cobots recognize objects, detect defects, or track human gestures accurately.
2. Machine Learning : Cobots can learn optimal movement patterns or adapt to varied materials over time, improving efficiency and reducing programming complexity.

- 108.** Why is adaptability critical for a robot working in a dynamic environment?

Ans :

MAIN 205

Dynamic environments involve unpredictable factors like changing object locations, variable sizes, or moving humans. Adaptability via sensors and control algorithms allows the robot to modify its path or actions on the fly. This prevents accidents, reduces downtime, and maintains productivity when conditions deviate from initial assumptions.

- 109.** Explain how a robot differs from a programmable machine that lacks sensors.

Ans :

SQP 2022

A robot possesses the capacity for closed-loop control, adjusting its actions based on real-time data. A programmable machine without sensors can only execute predetermined instructions, failing to adapt if external conditions change. In contrast, robots refine or alter operations continuously using sensor feedback.

- 110.** Discuss the role of shared workspaces in modern manufacturing.

Ans :

COMP 2024

Shared workspaces allow humans and cobots to simultaneously handle parts of a process, cutting down production time. This integration harnesses the unique strengths of each—humans for creativity and fine manipulation, cobots for accuracy and endurance—leading to agile and efficient production with quicker turnover.

- 111.** How does a cobot handle variations in part alignment on an assembly line?

Ans :

MAIN 2021

Using vision or proximity sensors, the cobot detects the part's precise orientation or location. It adjusts its gripper position or approach angle accordingly. This real-time correction prevents errors or damage, enabling the cobot to handle slight inconsistencies without halting the entire assembly line.

- 112.** Describe one economic benefit of adopting cobots.

Ans :

SQP 2023

Cobots can reduce labor costs for repetitive or labor-intensive tasks while enhancing overall throughput. By collaborating with human workers rather than replacing them entirely, they improve efficiency and quality. Their flexible nature and simple programming also limit downtime, yielding a faster return on investment.

- 113.** In what way are cobots transforming service industries?

Ans :

COMP 2013

From hospitality to healthcare, cobots can provide assistance in tasks like delivering items, aiding staff with repetitive activities, and supporting patient rehabilitation exercises. Their safety features and adaptability make them suitable for environments where direct interaction with people is crucial, improving service quality and consistency.

- 114.** Discuss the concept of multi-robot systems including cobots.

**Ans :**

MAIN 2016

Multi-robot systems involve multiple robots or cobots working in coordination, sometimes in conjunction with humans. Tasks are divided among robots—some fully automated, others collaborative—maximizing resource utilization. Communication protocols, centralized scheduling, and sensor networks ensure synchronization and safety, resulting in higher productivity and adaptability across different operations.

## CASE BASED QUESTION

- 115.** A small bakery wants to automate the packaging of delicate pastries without damaging them. Workers must still perform finishing touches by hand, but packaging is repetitive. How can a cobot help?

**Ans :**

A cobot can be programmed with force-limiting capabilities to gently pick pastries and place them in boxes. It will work alongside bakers, who add final decorations or quality checks. The cobot's sensors ensure it doesn't crush pastries, while its adaptability allows quick changes if product sizes vary.

- 116.** A pharmaceutical lab needs to handle tiny vials for testing. Human workers are prone to repetitive strain injuries. How do cobots address this?

**Ans :**

By integrating a cobot with precision grippers and vision guidance, the lab can automate vial handling. Workers load trays or supervise tasks rather than perform thousands of repetitive motions. The cobot's force control and small footprint safeguard the delicate vials and reduce injury risks for human staff.

- 117.** A car assembly unit wants to improve the process of installing tires. Currently, workers manually position heavy tires onto wheel hubs. Propose a cobot-based solution.

**Ans :**

A cobot with an appropriate end-effector could lift and align tires precisely, reducing the physical

strain on workers. Proximity sensors ensure the cobot slows down if a worker's hand is in the vicinity. This speeds up the tire installation process while maintaining safety and minimizing musculoskeletal injuries.

- 118.** In a research facility, technicians manually measure and sort samples, frequently misplacing data. Suggest how a robot or cobot could solve this.

**Ans :**

A cobot equipped with an RFID or barcode scanner can accurately identify and sort samples into designated racks, logging data automatically to a central system. This minimizes human error in labeling and tracking. Meanwhile, technicians can focus on analyzing results rather than monotonous manual sorting tasks.

- 119.** A school wants to demonstrate the difference between a simple machine and a robot to students. Suggest two classroom demos.

**Ans :**

Demo 1 : Show a basic pulley or lever system to illustrate a simple machine's single-function, no-feedback design.

Demo 2 : Display a small educational robot that senses a line on the floor and follows it, highlighting how sensor feedback enables autonomous adaptation.

- 120.** Workers in a packaging facility occasionally suffer from repetitive motion injuries stacking boxes. A new manager proposes installing a collaborative arm. How would it help?

**Ans :**

The cobot can handle the repetitive, heavy lifting of boxes onto pallets, freeing workers from strenuous tasks. If a worker enters the cobot's workspace, its built-in sensors reduce speed or stop motion. This approach keeps workers safe, boosts efficiency, and cuts down on injury-related downtime.

- 121.** A company uses a standard industrial robot for welding in a fenced cell but now needs a system to assist in finishing delicate weld seams near human operators. Propose a cobot solution.

**Ans :**

A cobot with precision welding attachments and force-limiting actuators can be installed outside

the fenced area to collaborate with technicians. The cobot handles detailed final touches, while the human can guide or adjust settings. Safety sensors enable immediate slowdown or stop if the technician comes too close.

- 122.** A textile studio wants to automate partial stitching tasks. Operators still need to adjust fabrics for artistic designs. Why might a cobot be suitable?

**Ans :**

A cobot can handle repetitive stitching or cutting lines consistently, while designers focus on unique, artistic details. Its speed and path can be easily reprogrammed for different fabric patterns. Force or vision sensors keep the process safe if hands are near the needle, preserving the creative workspace.

- 123.** An electronics firm produces circuit boards with variable component layouts. Traditional robots struggle with these frequent changes. How do cobots solve this?

**Ans :**

Cobots can be quickly reprogrammed or taught new pick-and-place coordinates. They might use vision systems to identify component positions and alignment. If the layout shifts slightly, the cobot adjusts in real time. This flexibility suits high-mix, low-volume production common in electronics, reducing costly reconfiguration downtime.

- 124.** A startup is considering whether to purchase a simple automated machine or a cobot for a new product line that often changes specifications. Suggest a rationale.

**Ans :**

Since the product specifications change frequently, a cobot's easy reprogramming and built-in safety features make it ideal. It can quickly adapt to new tasks, handle collaborative workflows, and require fewer additional safety measures. While a simple machine may be cheaper initially, it would be less adaptable and require frequent manual adjustments.

- 125.** A bakery wants to automate the process of kneading dough. The system should be able to detect the dough's consistency and adjust the kneading force accordingly. Should they use a machine, a robot, or a cobot? Why?

**Ans :**

The bakery should use a robot because :

1. A machine (like a traditional dough mixer) would operate at a fixed speed without adjusting to the dough's consistency.
2. A robotic system with sensors can detect the dough's texture and modify the kneading force accordingly.
3. If human bakers need to work alongside the system, a cobot would be preferable, as it can safely interact with them while maintaining precision.

- 126.** An automobile factory wants to install an automated painting system for cars. The system should cover the entire car uniformly but does not need to interact with workers. What should they use : a machine, a robot, or a cobot? Explain.

**Ans :**

They should use a robot because :

1. A simple machine would only spray paint in a fixed pattern without adjusting for car size or shape.
2. A robotic arm can sense the car's dimensions, move accordingly, and ensure uniform painting.
3. A cobot is unnecessary since there is no need for direct human-robot interaction in this case.

- 127.** A warehouse needs an automated system to transport goods from shelves to packing stations while navigating obstacles. What should they use : a machine, a robot, or a cobot? Why?

**Ans :**

They should use a robot (Autonomous Mobile Robot - AMR) because :

1. A machine like a conveyor belt moves goods but cannot navigate obstacles.
2. A robot (AMR) can sense its surroundings, avoid obstacles, and adjust its path dynamically.
3. A cobot is unnecessary unless workers need to frequently interact with the transport system.

- 128.** A textile company wants an automated system to cut fabric based on specific designs. The system must detect variations in fabric thickness and adjust pressure. What should they use?

**Ans :**

They should use a robot because :

1. A machine would cut fabric in a fixed manner without adjusting for variations.
2. A robotic cutter can sense fabric thickness and modify cutting pressure accordingly.
3. If workers need to assist in the process, a cobot could be used for safer interaction.

**129.** A factory uses large industrial robots for welding. Workers must perform finishing touches after welding. How can they improve safety and efficiency?

**Ans :**

They should use a cobot because :

1. Traditional industrial robots operate in isolation and may pose safety risks to workers.
2. Cobots have sensors to detect human presence and adjust their speed and force, ensuring safe collaboration.
3. This improves efficiency while reducing the risk of injuries.

**130.** An airport wants an automated system to guide passengers through check-in and security checkpoints. Should they use a machine, a robot, or a cobot? Explain.

**Ans :**

They should use a robot because :

1. A machine like a ticket kiosk can only perform a single function.
2. A robotic assistant can interact with passengers, provide directions, and answer queries.
3. A cobot is not necessary unless the robot needs to physically assist passengers (e.g., helping the elderly with luggage).

**131.** A hospital wants a robotic assistant to help nurses by delivering medicine and supplies to different rooms. Should they use a machine, a robot, or a cobot?

**Ans :**

They should use a robot (autonomous service robot) because :

1. A machine (like a medication dispenser) only performs a fixed function.
2. A robot can navigate the hospital, avoid obstacles, and deliver medicine to the correct location.
3. A cobot could be used if direct human interaction is required, such as handing items to nurses.

**132.** A company wants a robotic system to help workers lift and position heavy objects safely. What should they use?

**Ans :**

They should use a cobot because :

1. A machine (like a crane) can lift heavy objects but lacks adaptability.
2. A robot could automate lifting but might not ensure worker safety in shared spaces.
3. A cobot can assist workers by sensing human presence and adjusting force, reducing strain and preventing injuries.

**133.** A school wants a robotic teaching assistant that can answer student questions and interact with them dynamically. Should they use a machine, a robot, or a cobot?

**Ans :**

They should use a robot because :

1. A machine (like an audio recorder) can only play pre-recorded lessons.
2. A robot can process voice inputs, answer questions, and interact with students.
3. A cobot is unnecessary unless physical interaction (e.g., passing materials) is needed.

**134.** A company is designing a robotic system to assist elderly individuals at home. It should provide reminders, help with small tasks, and detect falls. What type of system should they use?

**Ans :**

They should use a cobot because :

1. A machine (like a timer) only provides reminders without interaction.
2. A robot could assist, but a cobot is better since it needs to work safely with humans.
3. Cobots with AI can detect falls, remind users to take medicine, and assist in daily activities.

# CHAPTER 3

## COMPONENTS OF ROBOTS AS A SYSTEM

### SUMMARY

#### 1. USE OF GEARS IN ROBOTS

Gears transmit power and change the speed/torque of rotary motion in robotic mechanisms. They help in force amplification or reduction and aid in precise motion control. Example in robotics: Arm joints often use gear trains to achieve desired torque and speed.

#### 2. PRINCIPLES OF GEARS

1. Gear Teeth: Each gear has teeth that mesh with teeth of another gear.
2. Meshing: When two gears mesh, the rotation of one causes rotation of the other in opposite directions (for most gear sets).
3. Torque Transmission: Gears allow torque to be increased or decreased depending on their sizes (radii).

#### 3. TYPES OF GEARS

The gears are classified in the following types :

1. Spur Gear: Straight teeth, parallel to gear axis; used in low to moderate speed applications.
2. Helical Gear: Teeth cut at an angle; smoother, quieter operation at higher speeds.
3. Bevel Gear: Conical shape; transmits power between intersecting shafts (e.g., 90°).
4. Worm Gear: A screw-like (worm) meshes with a worm wheel; significant speed reduction and high torque output.
5. Rack and Pinion: Converts rotary motion to linear motion or vice versa.

#### 4. GEAR RATIO

The gear ratio is the ratio of the number of teeth (or diameter) of the driven gear to that of the driver gear.

Gear Ratio Formula:

$$\text{Gear Ratio} = \frac{\text{Teeth on Driven Gear}}{\text{Teeth on Driver Gear}}$$

Example - If a small gear with 10 teeth drives a larger gear with 50 teeth, the gear ratio is 50:10 (or 5:1). This means the larger gear turns 1 rotation for every 5 rotations of the smaller gear, increasing torque but reducing speed.

#### 5. SENSORS IN ROBOTICS

Sensors allow robots to perceive and interact with their environment by providing real-time data. This sensory information is vital for tasks such as object detection, navigation, and safety monitoring.

##### 5.1 Types of Sensors Based on Application

1. Vision Sensors: Cameras or image sensors for object detection, recognition, and guidance.
2. Tactile Sensors: Detect touch or pressure (e.g., robotic grippers to sense grip force).
3. Temperature Sensors: Measure heat or cold for system monitoring (e.g., detecting overheating).
4. Range and Proximity Sensors: Ultrasonic, infrared, or lidar to measure distances and avoid obstacles.
5. Motion Sensors: Detect movement or vibration (e.g., accelerometers, gyroscopes).
6. Navigation Sensors: GPS or inertial measurement units (IMUs) for location and orientation.
7. Speech Recognition: Microphones and AI algorithms to interpret spoken commands.

##### 5.2 Classification of Sensors

Sensors are classified in the following types :

1. Internal Sensors:
  - (i) Position Sensors: Monitor joint angles or linear displacement (e.g., potentiometers, encoders).
  - (ii) Velocity Sensors: Track speed of rotation or linear motion (e.g., tachometers).
  - (iii) Acceleration Sensors: Measure changes in velocity (e.g., accelerometers).

- (iv) Force Sensors: Detect magnitude of force or torque in joints.
- 2. External Sensors:
  - (i) Contact Type: Require direct physical interaction (e.g., bump switches).
  - (ii) Non-contact Type: Detect objects/conditions without touching (e.g., proximity sensors, cameras).

### 5.3 Functions of Sensors

Functions of Sensors are as follows :

1. Provide real-time feedback to the controller.
2. Enable autonomy and adaptability in robotic tasks.
3. Ensure safety (e.g., detecting obstacles, human presence).
4. Facilitate precise control of motion and interaction with the environment.

## 6. ACTUATORS

Actuators are components that convert electrical, hydraulic, or pneumatic energy into mechanical motion. In robotics, actuators drive joints, wheels, arms, grippers, and end-effectors.

### 6.1 Types of Actuators

1. Linear Actuators: Produce motion in a straight line. Examples: hydraulic or pneumatic cylinders, linear motors.
2. Rotary Actuators: Produce rotational motion. Examples: electric motors (DC, servo, stepper), geared motors.

## 7. EXAMPLES IN ROBOTIC MECHANISMS

1. Joints: Typically driven by rotary actuators (motors) coupled with gears or belts.
2. Wheels: DC motors with gear systems can drive mobile robots.
3. End-Effectors: Servo motors in robotic arms for opening/closing grippers.

## 8. CONTROLLER FOR A ROBOTIC SYSTEM

1. Examples of Control Systems in Daily Life
  - (i) Regulation of a Fan: A speed regulator adjusts electrical input to control fan speed.
  - (ii) Refrigerator: A thermostat senses internal temperature and switches the compressor on/off to maintain a set range.
  - (iii) Air Conditioner: Temperature sensor triggers cooling or maintains the desired temperature via feedback loops.

2. Control Systems in Robotics
  - (i) Meaning: Systems that process sensor inputs, compare them with desired setpoints, and command actuators accordingly.
  - (ii) Functions:
    - (a) Execute algorithms (e.g., PID control, feedback loops).
    - (b) Interpret sensor data.
    - (c) Generate appropriate signals for actuators.
3. Working: Receive input (sensor data or user commands), process using control logic, output signals to actuators, then read feedback to refine the next output.

## 9. DIFFERENCES BETWEEN MANUAL AND AUTOMATIC CONTROL SYSTEMS

1. Manual: Human operator directly adjusts parameters (e.g., using a dial or switch).
2. Automatic: The system self-regulates based on sensor feedback (e.g., closed-loop control).

## 10. BLOCK DIAGRAM REPRESENTATION

1. Input → Controller → Robot/Actuator → Feedback Sensor → (Back to Controller)
2. This closed-loop ensures continuous adjustment for accurate performance.

### 10.1 Illustration

1. Consider a robotic arm with a revolute joint.
2. A position sensor (e.g., an encoder) measures the joint's angular position.
3. The controller reads the sensor's feedback, compares it to the desired angle, and sends signals to the motor.
4. The motor (actuator) rotates the arm to match the target angle.
5. If there is a discrepancy, the controller corrects it, forming a closed-loop control system.

### 10.2 Key Takeaways

1. The synergy between sensors, actuators, and the controller is crucial for precise, adaptive, and safe robot operations.
2. Feedback-based control underpins modern robotics, allowing for real-time adjustments and autonomy.

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## MULTIPLE CHOICE QUESTION

- Which of the following best describes a gear's primary function in a robot?
  - To convert electrical energy to mechanical motion
  - To transmit force and change speed/torque between rotating shafts
  - To sense the angular position of a shaft
  - To provide a gripping mechanism

Ans :

MAIN 2025

(b) To transmit force and change speed/torque between rotating shafts  
Gears mesh with each other to transfer rotational power, allowing adjustments in torque and speed. While actuators generate motion, gears modify the output characteristics—such as increasing torque or reducing speed. Therefore, gears mainly serve in the transmission and modification of rotary motion in robotic systems.

- A gear ratio of 5:1 implies that \_\_\_\_\_.
  - The driver gear spins five times while the driven gear spins once
  - Both gears rotate at the same speed
  - The larger gear must have fewer teeth than the smaller gear
  - Torque decreases by a factor of five

Ans :

COMP 2024

(a) The driver gear spins five times while the driven gear spins once  
A 5:1 ratio means the driver gear must turn five rotations to produce one rotation of the driven gear. Consequently, the driven gear experiences an increase in torque proportional to that ratio but moves more slowly. The gear with more teeth typically rotates slower but delivers greater torque.

- Which gear type is commonly used to transmit motion between perpendicular shafts (e.g., at 90°)?
  - Spur gear
  - Helical gear
  - Bevel gear
  - Rack and pinion

Ans :

SQP 2023

(c) Bevel gear  
Bevel gears are typically conical in shape and are designed to intersect shafts at right angles (often

90°). Spur and helical gears are used for parallel shafts, whereas rack and pinion change rotary motion into linear motion or vice versa, not specifically for perpendicular shaft applications.

- Which of these sensors is classified as an external, non-contact type?
  - Limit switch
  - Tactile pad
  - Infrared proximity sensor
  - Force/torque sensor

Ans :

MAIN 2021

(c) Infrared proximity sensor  
Non-contact sensors measure parameters without physically touching the object. An infrared proximity sensor sends out IR light and measures reflections, detecting objects or distances externally. A limit switch and tactile pads require physical contact, and force sensors typically measure interaction forces within a joint (internal sensor).

- For detecting the angle of rotation in a robotic joint, which type of sensor is most appropriate?
  - Thermistor
  - Potentiometer or Rotary encoder
  - Ultrasonic sensor
  - Microphone

Ans :

SQP 2013

(b) Potentiometer or Rotary encoder  
To measure rotational angles, robots commonly use rotary encoders or potentiometers. These devices convert angular displacement into electrical signals, enabling precise feedback for closed-loop control. Thermistors measure temperature, ultrasonic sensors measure distance, and microphones capture sound—none specifically gauge a joint's rotational angle.

- An actuator that provides linear motion in a robot is commonly called a \_\_\_\_\_.
  - DC motor
  - Stepper motor
  - Pneumatic cylinder
  - Bevel gear

Ans :

COMP 2016

(c) Pneumatic cylinder  
A pneumatic cylinder uses compressed air to produce movement in a straight line. This linear motion can lift or push components in a robot. DC and stepper motors typically deliver rotary motion, and bevel gears are mechanical

transmission elements, not stand-alone actuators for linear displacement.

7. Which option correctly distinguishes a manual control system from an automatic one?
- Manual systems never require a human operator
  - Automatic systems rely on real-time sensor feedback for adjustments
  - Manual systems always have complex sensing modules
  - Automatic systems must be controlled entirely by humans

Ans :

MAIN 2015

(b) Automatic systems rely on real-time sensor feedback for adjustments

Automatic control systems continuously monitor feedback from sensors and self-adjust operating parameters to meet a target. In contrast, manual systems depend on a human operator to make changes (e.g., turning a dial or switch). Sensor-driven feedback loops are key to the autonomous function of automatic systems.

8. Which of the following is an example of an internal sensor?
- Microphone for speech recognition
  - Bump sensor on a mobile robot
  - Position encoder on a robotic joint
  - Ultrasonic sensor for obstacle detection

Ans :

SQP 2019

(c) Position encoder on a robotic joint

Internal sensors measure the robot's internal state, such as joint angles, velocities, or forces. A position encoder on a robotic joint directly tracks that joint's angle, classifying it as an internal sensor. Microphones and ultrasonic sensors detect external events and thus fall under external or environmental sensors.

9. In a feedback control loop for a robotic arm, the actuator's role is to \_\_\_\_\_.
- Measure the angle of the arm
  - Process sensor data and issue commands
  - Provide mechanical motion based on control signals
  - Send error signals back to the controller

Ans :

COMP 2006

(c) Provide mechanical motion based on control signals

Actuators are devices (e.g., motors) that convert control signals into physical motion—rotational

or linear. While sensors measure angles and the controller processes signals, actuators carry out the necessary mechanical movement. The control loop includes sensors, a controller, and an actuator operating together to achieve the desired motion.

10. A simple block diagram of a robotic control system typically includes: Input → Controller → \_\_\_\_\_ → Feedback.

- Human operator
- Actuator (Robot)
- Gear ratio
- Sensors only

Ans :

MAIN 2012

(b) Actuator (Robot)

In a standard closed-loop diagram, the controller receives inputs (e.g., commands or sensor data), sends commands to the actuator (the robotic mechanism), and then receives feedback from sensors to adjust subsequent commands. "Actuator (Robot)" is the element that physically executes the controller's instructions, thus completing the loop.

11. A gear train is designed so that the output gear is larger than the input gear. This typically results in \_\_\_\_\_.
- Increased output speed and reduced torque
  - Reduced output speed and increased torque
  - No change in speed or torque
  - Increased energy consumption only

Ans :

SQP 2018

(b) Reduced output speed and increased torque

A larger output gear driven by a smaller input gear decreases rotational speed but boosts torque. The ratio of teeth (or diameters) determines how many rotations the small gear makes per single rotation of the large gear, translating to a torque increase at the cost of speed.

12. Which sensor would be most appropriate for non-contact distance measurement in an outdoor mobile robot?
- Ultrasonic sensor
  - Lidar sensor
  - Potentiometer
  - Force sensor

Ans :

COMP 2011

(b) Lidar sensor

Lidar (Light Detection and Ranging) is excellent for longer-range, accurate distance measurements, even outdoors. Ultrasonic sensors can be used too,

but are more prone to interference and typically have shorter range. Potentiometers measure rotation internally, and force sensors measure contact forces, neither providing non-contact distance data externally.

- 13.** An internal sensor that measures acceleration along multiple axes is typically a(n) \_\_\_\_\_.  
 (a) Accelerometer  
 (b) Gyroscope  
 (c) Lidar module  
 (d) Thermocouple

Ans :

MAIN 2009

- (a) Accelerometer

Accelerometers measure linear acceleration along one or more axes. They're considered internal because they track the robot's motion (e.g., changes in velocity). Gyroscopes measure angular velocity, lidar modules measure distance to external objects, and thermocouples measure temperature, so only an accelerometer fits the definition of multi-axis acceleration sensing.

- 14.** Which of these is a rotary actuator?  
 (a) Rack and pinion  
 (b) Conveyor belt  
 (c) Servo motor  
 (d) Linear piston

Ans :

SQP 2014

- (c) Servo motor

A servo motor outputs rotational motion, making it a rotary actuator. Rack and pinion convert rotary to linear motion, a conveyor belt is driven by motors but is itself not an actuator, and a linear piston provides straight-line movement rather than rotation.

- 15.** A control system that relies on human action to adjust parameters (like turning a knob) is called a \_\_\_\_\_.  
 (a) Automatic system  
 (b) Open-loop system  
 (c) Hydraulic system  
 (d) Manual control system

Ans :

COMP 2007

- (d) Manual control system

In a manual control system, the user must actively modify controls—e.g., adjusting a valve or knob to maintain a condition (speed, temperature). Automatic systems use feedback loops to make real-time corrections. “Open-loop” and “hydraulic” refer to different system

characteristics, not exclusively manual-human interaction.

**16.** When a sensor in a robotic arm detects a deviation from the desired angle, the controller will typically \_\_\_\_\_.  
 (a) Ignore the deviation until manually reset  
 (b) Increase motor current to dangerous levels  
 (c) Generate an error signal and adjust the motor command  
 (d) Shut down the entire robot

Ans :

MAIN 2017

- (c) Generate an error signal and adjust the motor command

Feedback control systems continuously compare actual values to target values. Any difference (error) triggers the controller to adjust actuator signals. For example, if the arm's angle is off, the controller may increase or decrease motor power until the measured angle aligns with the desired setpoint.

- 17.** One advantage of using helical gears over spur gears is \_\_\_\_\_.  
 (a) Simpler tooth geometry  
 (b) Quieter and smoother operation at higher speeds  
 (c) Inability to handle heavy loads  
 (d) They only mesh at 90° angles

Ans :

SQP 2010

- (b) Quieter and smoother operation at higher speeds

Helical gears have angled teeth, providing gradual engagement and smoother power transmission compared to spur gears, resulting in reduced noise and vibration. This design often handles higher loads. Spur gears, with straight teeth, can be noisier and less smooth at higher speeds but are simpler and cost-effective.

- 18.** A speech recognition module in a robot would generally be classified as \_\_\_\_\_.  
 (a) An internal position sensor  
 (b) An external non-contact sensor  
 (c) A force feedback sensor  
 (d) A manual control element

Ans :

COMP 2008

- (b) An external non-contact sensor

Speech recognition involves detecting external sound waves without physical contact with the speaker. Therefore, it's an external, non-contact sensor. It captures audio input from

the environment and converts it to signals for processing. Internal sensors measure the robot's own state, and force sensors measure physical interactions.

19. Which actuator is best for precise control of a small robot's wheel rotations?
- Pneumatic cylinder
  - DC motor with encoder feedback
  - Worm gear set
  - Hydraulic ram

Ans :

MAIN 2022

(b) DC motor with encoder feedback  
A DC motor combined with an encoder provides both the power for rotation and the feedback for precise speed/position control. Pneumatic cylinders and hydraulic rams are typically used for linear motion or high force. A worm gear set is a transmission element, not an actuator by itself.

20. Control systems that do not use sensor feedback to adjust outputs are called \_\_\_\_\_.
- Closed-loop systems
  - Open-loop systems
  - Automatic feedback systems
  - Manual control systems

Ans :

SQP 2025

(b) Open-loop systems  
Open-loop systems rely on predetermined inputs and do not correct themselves based on sensor feedback. They simply run a set of instructions. Closed-loop systems monitor and adjust continuously, while manual and automatic refer to who or what makes control changes, not the presence or absence of feedback.

21. Which gear arrangement is useful for converting rotary motion into linear motion?
- Rack and pinion
  - Worm and worm wheel
  - Helical gear pair
  - Compound spur gear set

Ans :

COMP 2021

(a) Rack and pinion  
A rack is a gear with teeth laid out in a straight line, while the pinion is a round gear. Meshing them transforms rotation (pinion) into linear movement (rack) or vice versa. The other gear types primarily handle rotational motion between shafts.

22. In robotics, a “contact sensor” typically indicates \_\_\_\_\_.

- A sensor that operates without physical touch
- A sensor measuring joint angles internally
- A sensor that triggers upon touching an object
- A sensor using laser beams

Ans :

MAIN 2023

(c) A sensor that triggers upon touching an object  
Contact sensors require physical interaction with a target. Examples include bump switches or tactile sensors that register pressure or contact forces. Non-contact sensors use mechanisms like light, sound, or electromagnetic fields to detect objects or distances from a vantage without physical touch.

23. An example of an external contact sensor in robotics is a \_\_\_\_\_.
- Limit switch on a robot's arm end
  - Potentiometer measuring elbow rotation
  - Temperature sensor on a motor winding
  - Infrared range sensor

Ans :

SQP 2024

(a) Limit switch on a robot's arm end  
A limit switch is triggered when a physical part of the robot or an external object depresses it—thus “contact.” Potentiometers measure internal angles (internal sensor), temperature sensors typically measure internal conditions, and infrared sensors are external but non-contact.

24. The role of a feedback sensor in a closed-loop control system is to \_\_\_\_\_.
- Provide initial commands to the controller
  - Convert mechanical power to electrical power
  - Send data on the actual output, allowing error correction
  - Block the system from functioning at higher speeds

Ans :

COMP 2013

(c) Send data on the actual output, allowing error correction  
Feedback sensors measure the system's current state (e.g., position, speed, force) and relay that information back to the controller. By comparing actual values to the target setpoint, the system adjusts actuators to reduce errors, ensuring accurate performance.

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- 25.** What is the main advantage of using a worm gear in a robot's drivetrain?
- High-speed output with little torque
  - Low friction and simple design
  - Significant speed reduction and increased torque in a compact form
  - Ability to transmit motion through contactless sensing

Ans :

MAIN 2016

(c) Significant speed reduction and increased torque in a compact form

Worm gears offer large speed reduction ratios and a substantial torque multiplication in a compact space. They also often exhibit self-locking characteristics, preventing back-driving in certain setups. The design is more complex than spur gears, but it's ideal for scenarios requiring considerable torque at reduced speeds.

- 26.** A robotic vacuum cleaner's cliff sensor, preventing it from falling down stairs, is an example of \_\_\_\_\_.
- Internal force sensor
  - External non-contact sensor
  - Linear actuator
  - Manual control device

Ans :

SQP 2015

(b) External non-contact sensor

Cliff sensors, often infrared or optical sensors, detect a sudden drop in floor level without physical contact. They measure reflected signals to determine if the floor is missing beneath the sensor. This setup is external (environment-focused) and non-contact, ensuring the vacuum avoids falling.

- 27.** When integrating a temperature sensor in a robot's motor, it functions primarily to \_\_\_\_\_.
- Measure external ambient temperature only
  - Provide internal feedback about motor overheating risks
  - Adjust gear ratios automatically
  - Convert mechanical energy to electrical

Ans :

COMP 2019

(b) Provide internal feedback about motor overheating risks

Monitoring motor temperature can prevent overheating by signaling the controller to reduce speed or shut down if the motor gets too hot. While it measures temperature internally to the motor, it ultimately serves to protect the robot

by offering feedback about the motor's thermal state.

- 28.** A DC motor used in a robotic system requires a controller to \_\_\_\_\_.
- Provide mechanical advantage
  - Adjust voltage and current for desired speed/torque
  - Reduce friction in the gear train
  - Supply compressed air

Ans :

MAIN 2006

(b) Adjust voltage and current for desired speed/torque

A DC motor's speed and torque are primarily determined by the voltage and current supplied. The controller modulates these electrical parameters (e.g., via PWM signals) to achieve the desired motion. Mechanical advantage or friction reduction is handled mechanically, and compressed air is for pneumatic systems.

- 29.** Which is the best example of an internal velocity sensor?
- Tachometer measuring motor RPM
  - Infrared sensor measuring distance
  - Microphone measuring sound waves
  - Limit switch measuring contact

Ans :

SQP 2012

(a) Tachometer measuring motor RPM

A tachometer directly measures the rotational speed (RPM) of a motor or shaft, classifying it as an internal velocity sensor. Infrared and limit switches are external sensors, and a microphone captures sound. Tachometers are integral for feedback in closed-loop speed control systems.

- 30.** What component in the robot's control loop interprets feedback and decides how to adjust actuator signals?
- Sensor
  - Battery
  - Controller
  - Gear train

Ans :

COMP 2018

(c) Controller

The controller processes sensor inputs (feedback) and compares them to desired reference values. It then adjusts signals to actuators (e.g., motors) accordingly. Sensors gather data, batteries supply power, and gear trains transmit mechanical energy—but the controller is the decision-making center of the feedback loop.

- 31.** A robotic arm joint requires precise motion control at low to moderate speeds. Which gear type is most appropriate for transmitting power in this scenario?

(a) Helical Gear  
(b) Spur Gear  
(c) Worm Gear  
(d) Rack and Pinion

**Ans :**

MAIN 2011

(b) Spur Gear

Spur gears suit low to moderate speed applications in robotic arms due to their straight teeth design and efficient torque transmission. Their simplicity and reliability allow precise motion control and force amplification. This cost-effective gear type is ideal for achieving accurate performance in industrial robotic joints, ensuring consistent efficient operation.

- 32.** A small gear with 10 teeth drives a larger gear with 50 teeth in a robotic mechanism. What is the gear ratio?

(a) 10:50  
(b) 5:1  
(c) 1:5  
(d) 50:10

**Ans :**

SQP 2010

(b) 5:1

The gear ratio is calculated by dividing the number of teeth on the driven gear by the number of teeth on the driver gear. In this case, 50 divided by 10 equals 5. This means the larger gear rotates once for every five rotations of the smaller gear, increasing torque.

- 33.** A robotic gripper uses a sensor to determine the amount of force applied when grasping an object. Which sensor is most likely used?

(a) Position Sensor  
(b) Force Sensor  
(c) Temperature Sensor  
(d) Motion Sensor

**Ans :**

COMP 2008

(b) Force Sensor

Force sensors detect the magnitude of force or torque in robotic joints and end-effectors. In a robotic gripper, such sensors provide critical feedback to ensure that objects are held securely without causing damage. They enable precise control and adaptation during gripping tasks, thereby enhancing safety and operational efficiency in robotics.

- 34.** A robot's joint is rotated by an electric motor that drives it continuously. Which type of actuator is being used in this scenario?

(a) Linear Actuator  
(b) Rotary Actuator  
(c) Hydraulic Cylinder  
(d) Pneumatic Cylinder

**Ans :**

MAIN 2022

(b) Rotary Actuator

Rotary actuators convert energy into rotational motion, making them ideal for driving robot joints. Electric motors, including DC, servo, or stepper motors, exemplify rotary actuators. They provide controlled, continuous rotation necessary for precise positioning in robotic systems, enabling accurate execution of tasks such as joint movement in articulated robotic arms.

- 35.** A robotic arm employs an encoder to measure joint angles and adjusts its motor output accordingly. What type of control system does this exemplify?

(a) Open-Loop Control  
(b) Closed-Loop Control  
(c) Manual Control  
(d) Feedforward Control

**Ans :**

SQP 2021

(b) Closed-Loop Control

Closed-loop control systems continuously monitor feedback from sensors, such as encoders, to adjust actuator performance. In the robotic arm example, the encoder measures the joint angle and sends data to the controller, which then commands the motor to correct deviation. This self-regulating mechanism ensures precise, adaptive movement and consistent performance.

- 36.** A robot employs a camera to recognize objects without touching them. What type of sensor is this an example of?

(a) Internal Sensor  
(b) External Contact Sensor  
(c) External Non-Contact Sensor  
(d) Tactile Sensor

**Ans :**

COMP 2025

(c) External Non-Contact Sensor

A camera used for object recognition functions as an external non-contact sensor. It captures visual data without interacting physically with objects. This sensor type provides essential information for navigation and obstacle detection, allowing the robot to interpret its environment accurately.

and execute tasks with minimal interference or physical engagement effectively.

- 37.** A robot design requires transmitting power between shafts intersecting at  $90^\circ$ . Which gear type is most suitable?

(a) Spur Gear  
(b) Helical Gear  
(c) Bevel Gear  
(d) Worm Gear

**Ans :**

MAIN 2023

(c) Bevel Gear

Bevel gears, characterized by their conical shape, are specifically designed to transmit power between intersecting shafts, often at 90-degree angles. Their unique geometry enables smooth rotation between non-parallel axes, making them ideal for robotic mechanisms requiring directional change in motion while maintaining efficient torque transmission and mechanical reliability with precision.

- 38.** For a compact robotic application requiring significant speed reduction and high torque output, which gear is most likely employed?

(a) Spur Gear  
(b) Helical Gear  
(c) Worm Gear  
(d) Rack and Pinion

**Ans :**

SQP 2024

(c) Worm Gear

Worm gears resemble screw-like mechanisms and are effective at providing significant speed reduction while delivering high torque output. Their compact design and high torque capabilities make them suitable for applications in robotics where space is limited. They efficiently transmit power, offering precise control and stability in demanding mechanical environments consistently.

- 39.** Which component in a robotic system processes sensor inputs, compares them with setpoints, and commands actuators accordingly?

(a) Sensor  
(b) Actuator  
(c) Controller  
(d) Gear System

**Ans :**

COMP 2013

(c) Controller

The controller is the central component in a robotic system that processes sensor inputs, compares them with desired setpoints, and issues

commands to actuators. It executes algorithms, such as PID control, ensuring that robotic actions closely follow intended operations. This feedback loop facilitates precise, adaptive performance across various robotic applications.

**40.** An industrial robot uses a closed-loop system where position sensor feedback adjusts motor movement. What is the primary benefit of this integration?

(a) Increased Manual Control  
(b) Real-Time Adjustment  
(c) Higher Energy Consumption  
(d) Static Operation

**Ans :**

MAIN 2016

(b) Real-Time Adjustment

Integrating sensors, actuators, and controllers in a closed-loop system enables real-time adjustment of robot movements. Feedback from position sensors allows the controller to continuously correct motor actions, ensuring precise positioning and smooth operation. This dynamic integration enhances performance, safety, and adaptability in complex robotic tasks, improving system reliability and efficiency.

## ASSERTION AND REASON

- 41. Assertion (A):** A worm gear setup can produce high torque output.

**Reason (R):** Worm gears have angled teeth designed primarily for speed increase.

**Options**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
(b) Both Assertion and Reason are correct, but Reason is not the correct explanation.  
(c) Assertion is correct, but Reason is incorrect.  
(d) Assertion is incorrect, but Reason is correct.

**Ans :**

(c) Assertion is correct, but Reason is incorrect.

The assertion is correct: worm gears deliver considerable speed reduction and high torque multiplication. The reason is incorrect because worm gears are generally used for speed reduction, not speed increase. Their angled threads are designed to reduce speed while boosting torque, not to rotate faster.

- 42. Assertion (A):** An encoder on a robot's wheel can measure how far the robot has traveled.

**Reason (R):** Encoders track rotational motion, which can be converted to linear distance based on wheel circumference.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are correct, and the reason explains the assertion. An encoder records wheel rotations; multiplying rotations by the wheel circumference yields total distance traveled. Hence, the reason appropriately clarifies how measuring rotational movement translates into linear displacement for the robot.

- 43. Assertion (A):** Closed-loop control systems never require sensor data.

**Reason (R):** Closed-loop control depends on feedback signals to adjust outputs.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because closed-loop systems rely on sensor feedback to compare actual vs. desired performance. The reason is correct: feedback data is fundamental to any closed-loop design. Therefore, the assertion is wrong, but the reason correctly describes the nature of closed-loop control.

- 44. Assertion (A):** Gears in a robotic arm can alter torque at each joint.

**Reason (R):** Different gear ratios enable adjusting speed and torque according to task requirements.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but

Reason is not the correct explanation.

- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both the assertion and reason are true, and the reason logically explains the assertion. Gears indeed modify torque/speed delivered to the robotic arm joints, and by selecting appropriate gear ratios, engineers tailor mechanical output to suit the required strength or speed for each joint.

- 45. Assertion (A):** A position sensor is unnecessary if the robot operates in open-loop mode.

**Reason (R):** Open-loop control does not use feedback to correct errors.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

In open-loop systems, the robot does not rely on feedback, thus a position sensor is not strictly necessary for operation—though it might still be useful for monitoring. The reason accurately explains that open-loop control does not correct errors using sensor feedback, making the assertion valid and reason correct.

- 46. Assertion (A):** A linear actuator is ideal for rotating a robot's gripper.

**Reason (R):** Rotating parts require rotary motion, typically provided by motors or rotary actuators.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect—rotating a gripper is more efficiently achieved with a rotary actuator, not a linear actuator. The reason is correct:

rotating elements commonly use motors or gear-based rotary drives. Thus, the assertion is wrong, but the reason is a valid explanation of rotary motion needs.

- 47. Assertion (A):** Non-contact sensors provide information about external objects without physical contact.

**Reason (R):** Infrared, ultrasonic, and lidar are common forms of contact sensors.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(c) Assertion is correct, but Reason is incorrect. The assertion is correct: non-contact sensors measure or detect objects without touching them. The reason is incorrect because infrared, ultrasonic, and lidar are actually typical examples of non-contact sensors, not contact sensors. So, the assertion is correct, but the reason is stated incorrectly.

- 48. Assertion (A):** A gear ratio of 1:1 changes both speed and torque substantially.

**Reason (R):** A 1:1 gear ratio implies that driver and driven gears rotate at the same rate.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect; a 1:1 ratio does not substantially change speed or torque—both remain the same, aside from minor losses. The reason is correct, describing that driver and driven gears turn at identical speeds in a 1:1 setup. Hence, assertion is wrong, reason is correct.

- 49. Assertion (A):** Controllers in robotics can be analog only.

**Reason (R):** Microcontrollers often handle digital control, reading sensor data and outputting PWM signals.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because controllers can be analog or digital. Modern robotics frequently use digital microcontrollers or processors. The reason is correct: microcontrollers provide digital control signals (like PWM) to run motors, read sensor data, and adjust parameters in real time.

- 50. Assertion (A):** Using a force sensor at a robot's gripper can prevent excessive squeezing of delicate objects.

**Reason (R):** Force sensors detect the amount of pressure or force applied, allowing the controller to reduce actuator output if the force exceeds thresholds.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are correct, and the reason directly explains how force sensors protect fragile items. If measured force is too high, the controller signals the actuator to ease its grip, preventing damage. Thus, the assertion and reason align perfectly to describe force-sensitive handling in robotics.

## STATEMENT BASED QUESTIONS

- 51.** Consider the following statements about the use of gears in robots:

1. Gears transmit power and change the speed/torque of rotary motion in robotic mechanisms.

2. Gears are primarily used to convert linear motion into rotary motion.
- Only statement 1 is correct.
  - Only statement 2 is correct.
  - Both statements 1 and 2 are correct.
  - Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Gears are used to transmit power and adjust speed/torque; converting between linear and rotary motion is typically achieved with a rack and pinion, not with gears alone.

- 52.** Consider the following statements about the principles of gears:

- Each gear has teeth that mesh with those of another gear, enabling torque transmission.
  - When two gears mesh, the rotation of one causes the other to rotate in the same direction.
- Only statement 1 is correct.
  - Only statement 2 is correct.
  - Both statements 1 and 2 are correct.
  - Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

While gear teeth indeed mesh to transmit torque, in most gear sets the gears rotate in opposite directions, not in the same direction.

- 53.** Consider the following statements about gear ratios:

- The gear ratio is defined as the ratio of the number of teeth (or diameter) of the driven gear to that of the driver gear.
  - A gear ratio of 5:1 means that the larger gear rotates five times faster than the smaller gear.
- Only statement 1 is correct.
  - Only statement 2 is correct.
  - Both statements 1 and 2 are correct.
  - Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Statement 1 correctly defines the gear ratio. In a 5:1 ratio, the driver (smaller gear) must rotate five times for the driven (larger gear) to complete one rotation, which increases torque but reduces speed—not the other way around.

- 54.** Consider the following statements about types of gears:

- A spur gear has straight teeth and is used in low to moderate speed applications.
  - A helical gear has teeth cut at an angle, providing smoother and quieter operation at higher speeds.
- Only statement 1 is correct.
  - Only statement 2 is correct.
  - Both statements 1 and 2 are correct.
  - Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

Both statements accurately describe the characteristics and typical applications of spur and helical gears.

- 55.** Consider the following statements about sensors in robotics:

- Sensors provide real-time feedback to the controller, enabling autonomy, adaptability, and safety in robotic tasks.
  - Sensors in robotics are used solely for detecting obstacles.
- Only statement 1 is correct.
  - Only statement 2 is correct.
  - Both statements 1 and 2 are correct.
  - Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

While sensors indeed detect obstacles, they serve many functions such as monitoring joint positions, measuring force, and providing other feedback necessary for precise control and safe operation.

- 56.** Consider the following statements about the classification of sensors:

- Internal sensors, such as position sensors, velocity sensors, accelerometers, and force sensors, monitor a robot's internal parameters.
  - External sensors always require direct physical contact with objects to detect conditions.
- Only statement 1 is correct.
  - Only statement 2 is correct.
  - Both statements 1 and 2 are correct.
  - Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Statement 1 correctly lists types of internal sensors. Statement 2 is incorrect because external sensors can be non-contact (e.g., proximity sensors, cameras) and do not always require physical interaction.

**57.** Consider the following statements about actuators in robotic systems:

1. Actuators convert electrical, hydraulic, or pneumatic energy into mechanical motion.
  2. Linear actuators produce rotational motion, while rotary actuators produce linear motion.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Actuators indeed convert various forms of energy into motion. However, linear actuators produce straight-line (linear) motion and rotary actuators produce rotational motion—the opposite of what statement 2 asserts.

**58.** Consider the following statements about controllers in robotic systems:

1. A controller processes sensor inputs, compares them with desired setpoints, and commands actuators to adjust the robot's behavior.
  2. In a robotic control system, the controller operates without feedback, making decisions solely based on initial programming.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Controllers in robotic systems use feedback (closed-loop control) to continuously adjust performance. Statement 2 is incorrect because feedback is essential for accurate, adaptive control.

**59.** Consider the following statements regarding manual versus automatic control systems:

1. In a manual control system, a human operator directly adjusts parameters such as speed and direction.
  2. In an automatic control system, the system self-regulates using sensor feedback and closed-loop control without human intervention.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

The statements correctly describe the differences between manual and automatic control systems, with manual control requiring human input and automatic control relying on feedback loops for self-regulation.

**60.** Consider the following statements about integrating sensors, actuators, and controllers in a robotic system:

1. Integrating sensors, actuators, and a controller creates a closed-loop control system that continuously adjusts performance based on feedback.
  2. In a closed-loop control system, once the initial command is sent, no further feedback is used to modify the actuator outputs.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Statement 1 accurately describes a closed-loop system, which relies on continuous feedback to adjust performance. Statement 2 is incorrect because the essence of closed-loop control is to constantly use feedback to refine actuator commands.

**61.** Choose the correct statement about manual vs. automatic control systems.

- (a) Automatic control systems do not use sensors.
- (b) Manual systems rely on user adjustments, while automatic systems self-regulate via feedback.
- (c) Both manual and automatic systems continuously use feedback loops.
- (d) Manual systems operate independently of human interaction.

**Ans :**

(b) Manual systems rely on user adjustments, while automatic systems self-regulate via feedback. Manual systems need a human operator to modify outputs (e.g., turn a knob). Automatic systems measure feedback through sensors and adjust actuator outputs automatically based on setpoints. Thus, statement (b) accurately reflects this fundamental distinction in control system design.

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- 62.** Which statement about internal sensors is correct?
- They measure environment factors like temperature outside the robot.
  - They track the robot's internal states, such as joint positions and motor currents.
  - They sense obstacles around the robot.
  - They are always contact sensors for bump detection.

**Ans :**

(b) They track the robot's internal states, such as joint positions and motor currents.

Internal sensors provide data on the robot's own status (e.g., angles, speeds, forces, currents). By contrast, environmental sensing (obstacles, external temperature, etc.) is performed by external sensors. Contact sensors typically detect external collisions. Hence, statement (b) correctly characterizes internal sensors.

- 63.** Select the correct statement regarding gear types.
- Spur gears are used for perpendicular shaft transmission.
  - Helical gears are noisier than spur gears at high speeds.
  - Bevel gears are used for parallel shafts.
  - Worm gears can achieve significant reduction and are often self-locking.

**Ans :**

(d) Worm gears can achieve significant reduction and are often self-locking.

Worm gears deliver large speed reductions, increased torque, and can exhibit self-locking properties (i.e., the worm wheel cannot easily drive the worm). Spur gears are for parallel shafts and can be noisier at high speeds. Helical gears are quieter, and bevel gears handle perpendicular shafts.

- 64.** Which statement about contact and non-contact sensors is correct?
- Contact sensors require physical interaction; non-contact sensors do not.
  - Contact sensors are always internal sensors.
  - Non-contact sensors measure only internal joint angles.
  - Both sensor types physically touch objects in different ways.

**Ans :**

(a) Contact sensors require physical interaction; non-contact sensors do not.

Contact sensors (e.g., bump switches, tactile pads)

must touch an object to register data. Non-contact sensors (e.g., IR, ultrasonic) measure distance or detect presence without physical contact. They can sense external objects from a distance. Hence, statement (a) accurately encapsulates the main difference.

- 65.** Identify the correct statement about closed-loop control.
- It makes no use of sensors.
  - It relies on feedback to correct deviations from the setpoint.
  - It depends solely on manual input.
  - It is the same as an open-loop system.

**Ans :**

(b) It relies on feedback to correct deviations from the setpoint.

Closed-loop control requires continuous comparison between sensor feedback and the desired target. If an error is detected, the system adjusts actuator commands accordingly. Sensors are mandatory for feedback. Manual input is optional but not essential for closed-loop functionality. Hence, (b) correctly describes closed-loop operation.

- 66.** Which statement best describes the integration of sensors, actuators, and controllers in a robot?
- Sensors direct mechanical power to the robot's joints.
  - The controller processes sensor data and commands actuators to achieve desired motion.
  - Actuators collect data, and sensors interpret it.
  - The system relies entirely on manual adjustments.

**Ans :**

(b) The controller processes sensor data and commands actuators to achieve desired motion.

In an integrated system, the controller is the decision-making unit. It interprets data from sensors and uses this information to provide signals to actuators. Actuators then carry out the mechanical work. Sensors do not supply mechanical power; they supply data. Manual adjustments are not mandatory in automated control.

- 67.** Which statement correctly describes gear ratio effects?
- A high gear ratio means increased speed and decreased torque.

- (b) A high gear ratio means the driven gear turns faster than the driver gear.
- (c) A high gear ratio typically increases torque while reducing output speed.
- (d) A high gear ratio has no effect on speed or torque.

**Ans :**

(c) A high gear ratio typically increases torque while reducing output speed.

When the driven gear is larger (more teeth) than the driver gear, we say the ratio is high (e.g., 4:1). This setup multiplies torque but reduces rotational speed correspondingly. Hence, statement (c) accurately describes the relationship between torque and speed in a high gear ratio scenario.

- 68.** Which statement about sensors in robotics is correct?
- (a) Internal sensors measure the environment's temperature and lighting conditions.
  - (b) External non-contact sensors detect objects without physical touch.
  - (c) Contact sensors measure force without needing any physical interaction.
  - (d) Tactile sensors are the same as vision sensors.

**Ans :**

(b) External non-contact sensors detect objects without physical touch.

External, non-contact sensors include devices like infrared, ultrasonic, and lidar sensors that detect objects at a distance without physical contact. Internal sensors measure parameters like joint angle or motor current. Tactile or contact sensors require physical interaction, while vision sensors process images (also non-contact but not tactile).

- 69.** Identify the correct statement about actuators.
- (a) A rotary actuator provides linear motion.
  - (b) A linear actuator always uses electricity only.
  - (c) Actuators convert electrical, hydraulic, or pneumatic energy into mechanical motion.
  - (d) Actuators do not require a power source to operate.

**Ans :**

(c) Actuators convert electrical, hydraulic, or pneumatic energy into mechanical motion.

Actuators transform various energy forms (electrical, hydraulic, pneumatic) into physical motion. Rotary actuators output rotational movement, while linear actuators provide straight-line motion. They certainly require a power source

and do not always rely solely on electricity (they may use compressed air or hydraulic fluid).

- 70.** Which is the correct statement about a robot's controller?
- (a) It supplies mechanical power to the robot's joints.
  - (b) It interprets sensor data and computes appropriate actuator commands.
  - (c) It physically senses collisions with external objects.
  - (d) It always relies on manual user input for adjustments.

**Ans :**

(b) It interprets sensor data and computes appropriate actuator commands.

The robot's controller is essentially the "brain," processing inputs from sensors and comparing them to desired values. Then it commands actuators accordingly. It does not directly supply mechanical power (that comes from actuators and the power source). Automatic adjustments result from embedded software, not purely manual input.

## PICTURE BASED QUESTIONS

- 71.** Observe the image:



Which of the following statements is correct?

- (a) Both gears increase speed only.
- (b) The worm gear provides significant speed reduction and high torque output.
- (c) The spur gear transmits power between intersecting shafts.
- (d) Both gears function identically in robotics.

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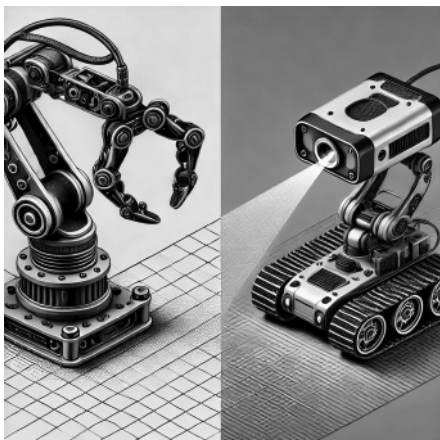
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Ans :

(b) The worm gear provides significant speed reduction and high torque output.

Spur gears are simple and used for low-to-moderate speed applications. Worm gears are used for large torque multiplication with high speed reduction.

72. Look at the images:



Which sensor types are involved?

- (a) Tactile sensor and proximity sensor.
- (b) Motion sensor and vision sensor.
- (c) Temperature sensor and tactile sensor.
- (d) Navigation sensor and temperature sensor.

Ans :

(a) Tactile sensor and proximity sensor.

Tactile sensors help detect contact and grip force. Proximity sensors (like LIDAR) measure distances and help robots navigate obstacles.

73. Consider the images:



Which statement is correct?

- (a) Both are examples of rotary actuators.
- (b) Linear actuators produce straight-line motion, while rotary actuators enable rotation.

(c) Actuators do not convert energy into mechanical motion.

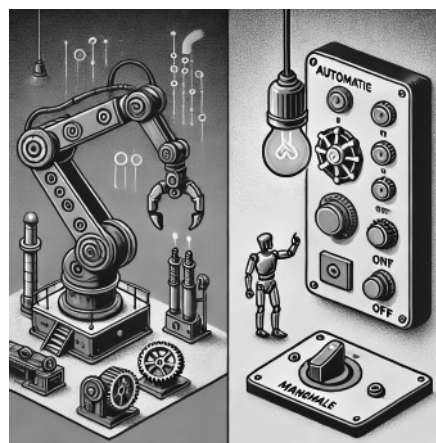
(d) Both actuators function the same way.

Ans :

(b) Linear actuators produce straight-line motion, while rotary actuators enable rotation.

Linear actuators move in a straight line (e.g., robotic arm extensions). Rotary actuators (motors) drive rotational motion (e.g., wheels, joints).

74. Look at the diagram:



Which best describes the control systems shown?

- (a) Both are manual control systems.
- (b) The robotic arm follows automatic control with feedback, while the switch is a manual control system.
- (c) Both require continuous human intervention.
- (d) Neither system involves actuators.

Ans :

(b) The robotic arm follows automatic control with feedback, while the switch is a manual control system.

Automatic control uses sensor feedback to adjust actuator movement (e.g., robotic arm). Manual control requires direct human action (e.g., a switch).

## TWO MARKS QUESTIONS

75. Define gear ratio and give one example.

Ans :

MAIN 2025

Gear ratio is the ratio of the number of teeth

(or diameter) of the driven gear to the driver gear, determining speed and torque changes. For example, a 40-tooth gear driven by a 10-tooth gear has a 4:1 ratio—quadrupling torque but quartering speed.

- 76.** State one common use of spur gears in robotics.

**Ans :** SQP 2013

Spur gears often drive parallel shafts in mechanisms like simple gearboxes, transferring power and adjusting speed/torque in robotic arms or conveyor systems due to their straightforward tooth design and ease of manufacturing.

- 77.** What is the main difference between a contact sensor and a non-contact sensor?

**Ans :** COMP 2006

Contact sensors require physical touch (e.g., bump switches), while non-contact sensors detect objects or measure distance without touching (e.g., IR, ultrasonic). This difference influences their applications for collision detection vs. range finding.

- 78.** Give an example of an internal sensor and its function.

**Ans :** MAIN 2021

A rotary encoder on a motor shaft measures angular position or speed. Its data help the controller adjust motor power for precise movement, forming the basis of closed-loop control.

- 79.** Why are force sensors important in robotic grippers?

**Ans :** SQP 2016

They measure the applied grip force, preventing damage to delicate objects. The controller reads force data and adjusts actuator power, ensuring secure yet gentle handling in tasks like picking fragile items.

- 80.** Name two types of actuators and briefly describe each.

**Ans :** COMP 2012

1. Linear Actuator: Produces straight-line motion, e.g., pneumatic or hydraulic cylinders.
2. Rotary Actuator: Produces rotational motion, e.g., DC motors or servo motors.

- 81.** Define a closed-loop control system with one example.

**Ans :**

MAIN 2023

A closed-loop system uses sensor feedback to compare actual output to a target setpoint, adjusting actuator signals to reduce errors. Example: A thermostat controlling a heating system based on temperature feedback.

- 82.** How does a controller differ from an actuator in a robot?

**Ans :** SQP 2015

The controller processes sensor data and decides what actions to perform. It sends commands to the actuator, which physically executes the motion by converting electrical or fluid power into mechanical movement.

- 83.** What is the purpose of a block diagram in explaining a robotic control system?

**Ans :** COMP 2018

A block diagram visually represents the flow of information and energy—showing how inputs, controller, actuators, and feedback sensors interact. It clarifies system structure and operation.

- 84.** Explain briefly the role of gears in modifying speed and torque.

**Ans :** MAIN 2024

By meshing gears of different sizes, speed and torque are inversely affected. Smaller driver gear to larger driven gear increases torque but reduces speed; larger driver to smaller driven does the opposite.

- 85.** What do we mean by “internal sensors” in robots?

**Ans :** SQP 2019

Internal sensors measure the robot’s own parameters such as joint angles, motor speeds, accelerations, or internal forces, providing data essential for closed-loop control of the robot’s movements.

- 86.** Why might a robot use multiple sensors for a single task?

**Ans :** COMP 2011

Sensor fusion increases accuracy and reliability. Different sensors (e.g., vision + proximity) complement each other, providing a richer data set. This redundancy helps mitigate errors or environmental interferences.

- 87.** Give one advantage of helical gears over spur gears in robotics.

**Ans :**

MAIN 2009

Helical gears run more smoothly and quietly at higher speeds due to angled teeth that engage gradually, which can enhance performance and reduce noise in robotic mechanisms.

- 88.** How does a limit switch function in a robot's motion control?

**Ans :**

SQP 2014

A limit switch detects physical contact at the extreme travel of a moving part. When triggered, it signals the controller to halt or change direction, preventing mechanical overrun or damage.

- 89.** Mention one benefit of using a worm gear setup.

**Ans :**

COMP 2010

Worm gears provide large reduction ratios in a compact space and can offer a self-locking feature where the driven gear cannot back-drive the worm, adding stability in holding loads.

- 90.** What is the difference between manual and automatic control in a simple phrase?

**Ans :**

MAIN 2007

Manual Control: Human adjusts parameters directly.

Automatic Control: Sensors and controllers self-regulate outputs based on feedback.

- 91.** Give one example of a vision sensor application in robotics.

**Ans :**

SQP 2008

A camera-based system used for object recognition and location in pick-and-place robots, enabling the robot to identify parts on a conveyor belt and accurately grasp them.

- 92.** How do position sensors aid in robot arm precision?

**Ans :**

COMP 2017

They feed real-time angular or linear displacement data to the controller, which adjusts motor outputs to minimize error, ensuring the arm moves to and holds exact positions.

- 93.** What is the function of a controller's feedback loop?

**Ans :**

MAIN 2022

It compares the measured output (sensor data) with the desired setpoint and adjusts actuator commands to correct any difference, achieving accurate and stable operation.

- 94.** Explain briefly how speech recognition can be integrated into a robot.

**Ans :**

MAIN 2024

A microphone captures audio; software (voice recognition) processes the signal, translating spoken commands into digital data. The robot's controller then interprets these commands to trigger relevant actions or responses.

**NODIA**

## THREE MARKS QUESTIONS

- 95.** Describe how changing gear ratios can affect a robotic arm's performance.

**Ans :**

MAIN 2025

1. **Torque vs. Speed:** High gear ratios increase torque but reduce speed, beneficial for heavy lifting or precision. Lower ratios yield faster motion but less torque.
2. **Energy Efficiency:** Proper ratios prevent motors from overloading and minimize energy wastage.
3. **Application Matching:** Engineers select ratios to balance speed, load capacity, and control.

- 96.** Explain the principle of a proximity sensor and give an example.

**Ans :**

SQP 2011

1. **Principle:** Emits a signal (e.g., IR light, ultrasonic pulse) and senses reflections or disruptions to detect object presence or distance.
2. **Example:** Ultrasonic sensor measuring distance by timing echoes. Widely used in mobile robots for obstacle detection and collision avoidance.

- 97.** How do internal sensors differ from external sensors? Give one example of each.

**Ans :**

COMP 2019

1. **Internal Sensors:** Measure the robot's internal states (joint angles, motor speeds, internal forces). Example: Rotary encoder for joint angle.

2. External Sensors: Detect environmental factors (object proximity, vision). Example: Infrared sensor to detect obstacles without physical contact.

**98.** Discuss two advantages of using servo motors as rotary actuators in robotic joints.

**Ans :** MAIN 2013

1. Precision: Built-in feedback mechanisms allow accurate control of position and speed.
2. Ease of Control: Servos typically come with integrated control circuitry, simplifying integration. They respond to simple pulse-width modulation signals for commanded angles.

**99.** Differentiate between manual and automatic control systems with suitable examples.

**Ans :** SQP 2024

1. Manual Control: A user adjusts outputs directly—e.g., turning a fan regulator knob to set speed.
2. Automatic Control: A system uses sensor data to self-regulate—e.g., an air conditioner cycles on/off based on thermostat readings to maintain set temperature.

**100.** Illustrate how a block diagram for a robotic arm's position control loop might look and describe each block.

**Ans :** COMP 2021

1. Blocks diagram: Setpoint → Controller → Motor/Actuator → Arm Joint → Position Sensor → (Feedback to Controller).
2. Description: The user or algorithm sets a target angle. The controller sends signals to the motor. The arm moves. The sensor reads actual angle and sends data back. The controller compares and corrects any error.

**101.** How do bevel gears differ from spur gears in terms of application?

**Ans :** MAIN 2016

1. Shaft Orientation: Bevel gears transfer motion between intersecting shafts (often 90°), while spur gears require parallel shafts.
2. Shape: Bevel gears have conical surfaces, spur gears have cylindrical shapes.
3. Use: Bevel gears are common in angled transmissions (e.g., differential drives in vehicles).

**102.** Explain the role of a temperature sensor in preventing motor overheating in a robot.

**Ans :** SQP 2015

1. Measurement: The sensor monitors motor temperature.
2. Feedback: If the temperature exceeds safe limits, the controller slows or stops the motor, or activates cooling measures.
3. Protection: Prevents permanent damage, maintaining the robot's reliability and extending motor lifespan.

**103.** Why might a robot require both position and velocity sensors at a joint?

**Ans :** COMP 2006

1. Position: Ensures the joint reaches the correct angle or location.
  2. Velocity: Controls the speed profile and dynamic performance.
- Combined: This dual feedback enables smooth, accurate movements, preventing sudden jerks and controlling inertia effectively during complex operations.

**104.** Discuss the importance of force feedback in surgical robots.

**Ans :** MAIN 2012

1. Delicate Touch: Surgeons need tactile feel to ensure precise incisions. Force sensors replicate that sense digitally.
2. Safety: Excessive force can damage tissues. Feedback helps maintain safe contact forces.
3. Accuracy: Real-time force data allows micro-adjustments, enhancing precision in minimally invasive procedures.

**105.** Explain how a controller adjusts a DC motor's speed using Pulse Width Modulation (PWM).

**Ans :** SQP 2018

1. Principle: PWM rapidly switches power ON and OFF. The duty cycle (ON vs. OFF time) determines effective voltage and thus speed.
2. Adjustment: The controller changes duty cycle in response to feedback. Higher duty cycles mean faster motor speed, and vice versa.

**106.** Briefly describe one scenario where manual control is preferable over automatic control.

**Ans :** COMP 2011

Custom Artisanal Operations: In tasks requiring human artistry or situational decisions (e.g., a sculpting process), immediate human input is more flexible and creative than pre-programmed automatic responses. Manual adjustments allow on-the-fly modifications to achieve desired aesthetics.

- 107.** How do rack and pinion gears assist in robotic applications needing linear motion?

**Ans :** MAIN 2009

1. Conversion: The pinion rotates, driving the linear rack.
2. Control: By controlling the pinion's rotation via a motor, the robot gains precise linear positioning (e.g., sliding a table or arm segment).
3. Versatility: Widely used in CNC machinery, pick-and-place robotics, and gates.

- 108.** Discuss the significance of sensor fusion in autonomous mobile robots.

**Ans :** SQP 2014

1. Improved Accuracy: Combining data from multiple sensors (e.g., lidar, camera, IMU) reduces uncertainty and error.
2. Robustness: If one sensor's data is noisy or blocked, others can compensate.
3. Navigation & Mapping: Sensor fusion aids in SLAM (Simultaneous Localization and Mapping) for reliable path planning.

- 109.** Why is feedback crucial in robotics for precise motion control?

**Ans :** COMP 2007

1. Error Correction: Feedback identifies differences between actual and desired positions.
2. Adaptability: Real-time adjustments handle disturbances (e.g., load changes).
3. Consistency: Maintaining stable performance across varied conditions fosters high accuracy and repeatability, essential in tasks like assembly or surgery.

- 110.** Explain how manual control can coexist with automatic features in a semi-autonomous robot.

**Ans :** MAIN 2017

1. Hybrid Approach: The robot operates automatically within certain limits, but an operator can override or fine-tune parameters.

2. Example: A drone with autopilot for stable hovering, yet a pilot can manually direct flight path or altitude changes if needed.

- 111.** Describe how a proximity sensor might help a robotic vacuum navigate a room.

**Ans :** SQP 2022

1. Obstacle Detection: The sensor identifies walls or furniture without contact.
2. Path Planning: Feedback is used to adjust the vacuum's route to avoid collisions.
3. Coverage Improvement: The robot efficiently moves around obstacles, cleaning larger areas without user intervention.

- 112.** How does integrating an actuator with a sensor form a mechatronic subsystem?

**Ans :** COMP 2008

1. Closed-Loop Operation: The sensor measures the actuator's output (speed, position, force).
2. Control: The controller adjusts the actuator based on real-time data to achieve set goals.
3. Synergy: This synergy underpins mechatronics, blending mechanical and electronic control seamlessly.

- 113.** Discuss the advantage of a high gear ratio in a robotic arm designed for heavy lifting.

**Ans :** MAIN 2010

1. Torque Amplification: The arm can lift heavier loads with smaller motors.
2. Precision: Slower motion at the output gear ensures careful, accurate placement.
3. Trade-off: Speed is reduced, which can be acceptable in applications focusing on safe, heavy load handling.

- 114.** Why are modern robotic controllers typically microcontroller- or microprocessor-based?

**Ans :** SQP 2021

1. Programmability: Software control allows complex algorithms (e.g., PID, AI).
2. Integration: A single chip can handle multiple inputs (sensors), outputs (actuators), and communication protocols.
3. Flexibility & Upgradeability: Changing or optimizing control logic is easier by reprogramming than redesigning hardware.

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## CASE BASED QUESTION

- 115.** A robotic arm assembling smartphones must place tiny screws accurately. The screws are small, and the torque must be precise. Discuss how gears, sensors, and a controller contribute.

**Ans :**

1. Gears: A high gear ratio reduces speed and increases torque, allowing gentle and precise rotation of the screwdriver bit.
2. Sensors: A small torque/force sensor can detect if screws are fully tightened. Position sensors ensure the arm locates each screw hole accurately.
3. Controller: Monitors feedback, halts rotation once the required torque is reached, ensuring consistent, damage-free assembly.

- 116.** A humanoid robot's elbow joint must lift a lightweight box, but at times the box's weight varies. How does a closed-loop system handle this?

**Ans :**

1. Sensors: A force or current sensor measures load changes.
2. Controller: Compares desired joint angle to actual angle under load, adjusting motor power.
3. Actuator: Delivers just enough torque to move the elbow smoothly, compensating for extra weight or lighter loads in real time.

- 117.** A factory robot needs to pick and place metal parts but must avoid accidental collisions with human workers on the floor. Suggest sensor choices.

**Ans :**

1. Proximity/Range Sensors: Ultrasonic or lidar sensors scan for humans within the robot's work zone.
2. Contact Sensors: Bump switches or tactile strips in case minimal collisions occur.
3. Implementation: The controller slows or stops the arm if a worker is detected nearby, ensuring safety.

- 118.** A mobile robot uses differential drive wheels and must navigate a warehouse full of shelves. How do actuators and sensors integrate?

**Ans :**

1. Actuators: Two DC motors, one per wheel, allow independent speed control for steering.
2. Sensors: Wheel encoders measure rotational speed for odometry, while ultrasonic or IR sensors detect obstacles.
3. Controller: Combines distance data, adjusts wheel speeds to dodge shelves, and tracks position accurately for route planning.

- 119.** In a temperature-sensitive process, a robot must maintain its internal motors below a certain threshold to avoid damage. Propose a solution.

**Ans :**

1. Sensors: Temperature probes on each motor winding.
2. Controller: Monitors real-time temperature data. If it exceeds the threshold, speed or duty cycle is lowered, or a cooling fan is activated.
3. Outcome: Motors remain within safe operating limits, preventing overheating.

- 120.** A robotic gripper manipulates fragile glassware. How do force sensors and gear ratios ensure breakage is minimized?

**Ans :**

1. Gear Ratio: High ratio ensures slow, torque-controlled closing action.
2. Force Sensor: Detects contact pressure. If force approaches a certain threshold, the controller reduces actuator power to prevent breakage.
3. Feedback Loop: Real-time monitoring of grip force yields safe yet firm handling.

- 121.** A researcher wants to measure the exact rotation angle of a robot's joint for a medical application. Which sensor and control method would you suggest?

**Ans :**

1. Sensor: A high-resolution rotary encoder for precise angle measurement.
2. Control Method: Closed-loop PID (Proportional-Integral-Derivative) ensures fine-tuned control. Encoder feedback constantly updates the controller, which adjusts motor signals to achieve accurate positioning essential for medical tasks.

- 122.** A small conveyor system in a sorting robot runs too quickly, causing items to misalign. How might gears resolve this?

Ans :

1. Gear Reduction: Installing a larger driven gear slows conveyor speed relative to the motor.
2. Benefit: Items remain more stable and aligned.
3. Implementation: The controller can further refine speed or stop the belt at key moments for precise sorting operations.

**123.** A drone for delivery needs stable flight and accurate navigation. Which sensors are vital, and how do they integrate with the controller?

Ans :

1. Vital Sensors: IMU (accelerometer + gyroscope) for orientation, GPS for location, possibly a barometer for altitude.
2. Integration: The controller fuses data to stabilize the drone (adjusting motor speeds) and follow designated routes. Real-time corrections ensure accurate, stable flight.

**124.** A robotic arm uses a position sensor but sometimes overshoots the target angle. How can the controller fix this issue?

Ans :

1. Closed-Loop Tuning: The controller might refine PID parameters to reduce overshoot.
2. Sensor Calibration: Ensuring accurate angle feedback is vital.
3. Actuator Command Adjustment: Slow down approach near target or use a feed-forward strategy to anticipate inertia.
4. Result: Minimizes overshoot and achieves stable positioning.

# CHAPTER 4

## VISUALIZATION, DESIGN AND CREATION OF COMPONENTS

NODIA

### SUMMARY

#### 1. MECHANICAL BLOCK OF ROBOTICS

##### 1.1 Definition and Purpose

1. The mechanical block (or mechanical subsystem) of a robot includes all structural and moving components.
2. It provides the robot's form, houses actuators and sensors, and ensures precise motion (rotational or linear).

##### 1.2 Visualizing, Designing, and Creating Robot Components

1. CAD Tools : Tinkercad, Fusion 360, or similar software help visualize and prototype robot parts.
2. Common Robotic Components : Frames, arms, joints, end-effectors (grippers or tools).
3. Material Considerations : Plastics or metals (in real builds) must be strong yet lightweight.

##### 1.3 Using Tinkercad for 3D Design

1. Interface : Simple, browser-based platform for creating 3D models.
2. Workflow :
  - (i) Create or import shapes (cylinders, boxes, etc.).
  - (ii) Arrange and group shapes to form a robotic part (e.g., arm link).
  - (iii) Simulate basic movement or export designs for further simulation/3D printing.

#### 2. TYPES OF JOINTS IN ROBOTICS

##### 2.1 Revolute Joints

1. Provide rotational motion around a fixed axis.
2. Commonly found in robotic arms (e.g., shoulder, elbow joints).

3. Symbolized as R in kinematic notation (e.g., R-joint).

##### 2.2 Prismatic Joints

1. Provide linear (sliding) motion.
2. Often used in Cartesian/gantry robots or adjustable end-effectors.
3. Symbolized as P in kinematic notation (e.g., P-joint).

#### 3. RR MECHANISM

1. A two-joint robotic linkage consisting of two revolute joints in sequence (R-R).
2. Common in planar robotic arms where each joint rotates.
3. Allows an arm to sweep a 2D plane, changing angles at two revolute connections.

#### 4. VISUALIZATION OF MOTION

##### 4.1 Why Visualization Matters

1. Helps understand how each joint moves, identifies potential collisions or design flaws.
2. Aids in verifying geometry, motion range, and functionality before physical fabrication.

##### 4.2 Using Tinkercad to Visualize Motion

1. Assembly : Model each link as a separate part; align them with pivot points where joints should be.
2. Simulation : While Tinkercad doesn't offer advanced physics, you can rotate components around pivot axes to check clearances and angles.

##### 4.3 Benefits of CAD-Based Visualization

1. Detect errors in dimensions or alignment early.
2. Adjust design parameters (lengths, angles, hole placements) efficiently.
3. Save time and cost before moving to physical prototypes.

## MULTIPLE CHOICE QUESTION

1. What does the “mechanical block” of a robot primarily refer to?
- The electronic sensors the robot uses
  - The user interface for controlling the robot
  - The structural and moving components of the robot
  - The computer code driving the robot’s functions

**Ans :**

MAIN 2025

- (c) The structural and moving components of the robot

The mechanical block encompasses the robot’s physical framework, joints, and moving parts—essentially its “skeleton.” It is distinct from electronic sensors or programming. Understanding the mechanical block is key to ensuring proper structure, motion, and integration with actuators and sensors for complete robotic functionality.

2. Which platform is commonly used to visualize and design 3D robotic components online?
- Tinkercad
  - Microsoft Paint
  - Spreadsheet software
  - Web browser text editors

**Ans :**

SQP 2021

- (a) Tinkercad

Tinkercad is a web-based 3D modeling tool widely used for quick prototyping and basic simulations. It allows users to create or import shapes, align them, and visualize complex assemblies. While other CAD tools exist, Tinkercad’s simplicity and accessibility make it a popular choice for beginners.

3. A revolute (R) joint in robotics provides motion that is primarily \_\_\_\_\_.
- Linear translation
  - Rotational around an axis
  - Random zigzag movement
  - Elastic deformation

**Ans :**

COMP 2023

- (b) Rotational around an axis

Revolute joints rotate around a fixed axis, similar to a hinge. This rotational motion is common in robotic arms (shoulders, elbows, wrists). Prismatic joints, by contrast, slide linearly. Revolute joints do not provide linear shifts, and they are not

elastic or random in motion.

4. Prismatic (P) joints allow a robot to \_\_\_\_\_.
- Pivot like a hinge
  - Slide or translate in a linear direction
  - Twist in multiple axes simultaneously
  - Capture visual data

**Ans :**

MAIN 2024

- (b) Slide or translate in a linear direction

Prismatic joints produce straight-line movement. They are often used in robotic systems requiring adjustable reach or height, such as linear actuators. Unlike revolute joints, they do not rotate about an axis but translate along a single path, which is essential in Cartesian or gantry-style robots.

5. In a robotic arm with an RR mechanism, “RR” stands for \_\_\_\_\_.
- Revolute-Revolute
  - Robot-Robot
  - Rectangular-Rotary
  - Roller-Rack

**Ans :**

SQP 2013

- (a) Revolute-Revolute

RR stands for Revolute-Revolute, indicating two sequential revolute joints. Each joint can rotate independently, enabling planar arm segments to change angles relative to each other. Such mechanisms are common in 2D manipulators or simpler robotic arms where two hinges provide the necessary degrees of freedom.

6. Which of the following best describes Tinkercad’s role in robotic design?
- It replaces all real hardware testing
  - It provides advanced physics simulations of robot motion
  - It serves as a simple 3D modeling tool for creating and visualizing parts
  - It automatically codes a robot’s microcontroller

**Ans :**

COMP 2016

- (c) It serves as a simple 3D modeling tool for creating and visualizing parts

Tinkercad offers an easy, browser-based interface for designing 3D models. It helps visualize shapes, sizes, and basic movements of robotic assemblies before physical fabrication. While it can demonstrate rudimentary motion or alignments, it does not fully replicate physical testing nor generate microcontroller code automatically.

7. When visualizing a revolute joint in Tinkercad, the user typically \_\_\_\_\_.
- Slides the component along a straight line
  - Rotates a part around a defined pivot axis
  - Runs a complex physics engine to detect collisions
  - Relies solely on textual programming scripts

Ans :

MAIN 2015

(b) Rotates a part around a defined pivot axis  
 Revolute joints revolve around a specific pivot. In Tinkercad, designers place a rotation axis (or pivot point) and rotate the part to check angles and clearances. Advanced features like dynamic collision detection or programming scripts are limited; Tinkercad excels at intuitive rotation/translation for conceptual visualization.

8. A prismatic joint is most similar in function to which real-life example?
- Door hinge
  - Desk drawer sliding in and out
  - Fan blade spinning
  - Ball-and-socket hip joint

Ans :

SQO 2019

(b) Desk drawer sliding in and out  
 Prismatic joints allow linear sliding, akin to how desk drawers move along rails. Door hinges rotate around a pin (revolute), fans spin, and ball-and-socket joints enable multi-axis rotation. The straightforward in-out motion of a drawer closely matches a prismatic joint's linear translation.

9. In robotic terminology, a “mechanical linkage” is best described as \_\_\_\_\_.
- A set of interconnected mechanical elements transmitting motion
  - A purely electronic circuit
  - A software tool for coding
  - A decorative part with no functional movement

Ans :

COMP 2006

(a) A set of interconnected mechanical elements transmitting motion  
 Mechanical linkage refers to the interconnected rods, gears, or joints that transmit power and motion within a mechanism. Robotic arms often have linkages that convert actuator output into specific movements. They are not electronic or software-based but tangible, functional arrangements of parts.

10. Which statement accurately reflects the difference between a single revolute joint and an RR mechanism?

- A single revolute joint offers two rotational DOF
- An RR mechanism has only linear motion
- An RR mechanism has two revolute joints in series
- A single revolute joint requires a second prismatic joint

Ans :

MAIN 2012

(c) An RR mechanism has two revolute joints in series  
 An RR mechanism is simply two consecutive revolute joints, providing two rotational degrees of freedom. A single revolute joint offers one DOF (rotation around one axis). This arrangement does not involve any prismatic (linear) motion, and each revolute joint rotates independently.

11. How does Tinkercad aid in “visualizing motion” before physical prototyping?

- It automatically manufactures robot parts
- By enabling designers to rotate or slide components in a virtual 3D space
- By providing instantaneous dynamic collision analysis
- By generating a bill of materials for the entire robot

Ans :

SQP 2018

(b) By enabling designers to rotate or slide components in a virtual 3D space  
 Tinkercad's user-friendly 3D environment allows designers to position pivot points and simulate basic movements (rotation, translation) of each part. This helps reveal spacing or alignment issues before real-world assembly. It does not automate manufacturing or advanced collision detection, but it's invaluable for early conceptual checks.

12. Which factor is least likely to be examined through Tinkercad's basic motion visualization?

- Range of motion for each joint
- Potential collisions between large parts
- Realistic material stress under heavy loads
- Required angles of rotation for assembly

Ans :

COMP 2011

(c) Realistic material stress under heavy loads  
 Tinkercad offers rudimentary geometry checks but does not include comprehensive stress/strain analysis or advanced physics. Engineers must

use dedicated simulation tools (like Fusion 360 or SolidWorks Simulation) to analyze material integrity. However, Tinkercad can help visualize whether the design fits and moves as intended.

- 13.** When simulating an RR mechanism in Tinkercad, the second R typically refers to \_\_\_\_\_.  
 (a) A second linear slide  
 (b) A second prismatic extension  
 (c) A second revolute joint that follows the first  
 (d) A rotational axis that moves only horizontally

Ans :

MAIN 2011

(c) A second revolute joint that follows the first  
 RR stands for two sequential revolute joints. The second “R” is simply another hinge or pivot that depends on the first link’s position. This chain of revolute joints allows more complex angular motion, making it possible for robotic arms to change shape in a plane.

- 14.** Which of the following is a primary advantage of using a CAD tool like Tinkercad for robot design?  
 (a) Replacing mechanical engineers entirely  
 (b) Instant real-time physics for dynamic tasks  
 (c) Quick conceptual prototyping and dimension checking  
 (d) Detailed analysis of circuit logic and code debugging

Ans :

SQP 2009

(c) Quick conceptual prototyping and dimension checking  
 Tinkercad excels at swiftly visualizing ideas, verifying dimensions, and generating approximate layouts. It’s ideal for early-stage concept work or for educational purposes. Detailed dynamic simulations, circuit logic, or code debugging are outside Tinkercad’s scope, and it certainly doesn’t negate the need for experienced mechanical engineers.

- 15.** A “revolute joint” in Tinkercad is typically visualized by \_\_\_\_\_.  
 (a) Modifying the color of the part  
 (b) Aligning an axis around which the part can rotate  
 (c) Stretching a shape linearly  
 (d) Using advanced scripting to replicate real-time torque

Ans :

COMP 2014

(b) Aligning an axis around which the part can rotate

Revolute joints revolve around a fixed axis. In Tinkercad, the designer positions parts so that one can pivot relative to the other at the desired point. While the platform doesn’t replicate torque or real-time physics, it lets you rotate parts about a pivot to gauge motion feasibility.

- 16.** If a robot arm’s mechanical design uses P joints exclusively, the arm can move primarily \_\_\_\_\_.  
 (a) By sliding in multiple axes  
 (b) By rotating around shoulders and elbows  
 (c) By combining linear and rotary motions  
 (d) By no movement at all

Ans :

MAIN 2007

(a) By sliding in multiple axes  
 “P” stands for prismatic, meaning each joint slides along a single axis. A purely P-based robot typically has multiple linear slides in different directions. Such Cartesian or gantry configurations are suitable for tasks that demand straightforward x, y, z translations but lack rotational movement unless combined with other joint types.

- 17.** What is the main outcome of the “visualize motion” step in robotic design?  
 (a) Final code for the robot’s microcontroller  
 (b) The exact power requirement for each motor  
 (c) Confirmation that parts can move through desired ranges without interference  
 (d) Real-time collision detection in a fully physics-based environment

Ans :

SQP 2017

(c) Confirmation that parts can move through desired ranges without interference  
 Visualization of motion identifies whether arms, joints, or links can traverse their intended paths without physical overlap or misalignment. It’s an essential step before building or advanced simulation. Exact power needs, coding, or high-end physics typically require separate calculations or specialized software beyond basic visualization.

- 18.** Which Tinkercad feature specifically assists in aligning components for proper joint simulation?  
 (a) Text editing mode  
 (b) Grouping and ungrouping shapes  
 (c) The “Align” tool that precisely positions objects  
 (d) Automatic stress testing

Ans :

COMP 2010

(c) The “Align” tool that precisely positions objects

Tinkercad's "Align" tool allows users to select multiple objects and align them along axes or centers. This is crucial for accurate joint representation, ensuring pivots align perfectly. Grouping shapes merges them into single parts, but the Align tool is key for correct mechanical relationships.

19. When creating an RR robotic arm in Tinkercad, each link is best modeled as \_\_\_\_\_.  
 (a) A single extruded shape that doesn't move  
 (b) Two or three overlapping cylinders with no pivot  
 (c) Separate, moveable segments connected at defined pivot points  
 (d) A solid block with no separation

Ans :

MAIN 2008

- (c) Separate, moveable segments connected at defined pivot points

In an RR mechanism, each arm segment is distinct, joined by a pivot (revolute joint). Tinkercad allows you to model each segment separately, position them end to end, and then "rotate" them around the connection point to simulate the arm's motion. Merging everything into one block negates any visible joint.

20. Which statement is true about the mechanical block's function in a robot?  
 (a) It stores a robot's programming code  
 (b) It provides the structural framework and transmits mechanical power  
 (c) It handles all sensor data processing  
 (d) It supplies electrical power to the motors directly

Ans :

SQP 2022

- (b) It provides the structural framework and transmits mechanical power

The mechanical block comprises the robot's frame, joints, gears, and linkages, ensuring structural integrity and power transmission from actuators to end-effectors. Code processing and electrical power distribution occur within electrical/control blocks. Sensors feed data to controllers, whereas the mechanical block is responsible for the actual physical motion.

21. A prismatic joint in a Tinkercad model might appear as \_\_\_\_\_.  
 (a) A hinge rotating about a pin  
 (b) A sliding slot and slider arrangement  
 (c) A sphere joint with multiple degrees of

freedom

- (d) A gear train with meshing teeth

Ans :

COMP 2025

- (b) It provides the structural framework and transmits mechanical power

Prismatic joints slide in a single dimension, resembling a slot/rail with a block sliding within it. Tinkercad can show the relative alignment, allowing you to conceptualize how far the block can move. Hinge-like rotation or ball-and-socket motions are distinct from prismatic translation.

22. When modeling a simple robotic gripper in Tinkercad, which mechanical joint is most likely used for the "open-close" action?

- (a) Revolute joint at each finger  
 (b) Prismatic joint in the base  
 (c) Ball-and-socket for the finger tips  
 (d) Helical gear arrangement

Ans :

MAIN 2021

- (a) Revolute joint at each finger

Most grippers use small hinged (revolute) joints to pivot finger segments open and closed. A prismatic joint could be used in specialized sliding grippers, but the common approach is pivoting "fingers." Ball-and-socket or helical gears are less typical for basic open-close jaws.

23. In an RR planar arm, the second revolute joint's rotation is measured relative to \_\_\_\_\_.  
 (a) An absolute global frame  
 (b) The base frame only  
 (c) The first link's orientation  
 (d) Any arbitrary direction not connected to the arm

Ans :

SQP 2024

- (c) The first link's orientation

In a serial chain, the second joint's orientation depends on the position/orientation of the first link. The second revolute axis rotates relative to the prior link's angle. Each joint's movement is cumulative, creating a final pose that depends on all preceding links.

24. Why might a designer prototype basic motion in Tinkercad before advanced simulation software?

- (a) Tinkercad is more accurate than all other simulators  
 (b) Tinkercad automatically calculates stress and strain  
 (c) It's fast, user-friendly, and sufficient to check basic geometry and alignment

- (d) It lacks any advantage; advanced software is always preferable

Ans :

COMP 2023

- (c) It's fast, user-friendly, and sufficient to check basic geometry and alignment

Tinkercad's simplicity speeds up initial concept work. It lets designers visualize shapes, pivot angles, and potential collisions quickly. Once confident in the geometry, they may migrate to advanced platforms for detailed physics or stress analysis. Tinkercad offers an accessible starting point rather than a full engineering solution.

25. Which step is NOT part of using Tinkercad to create a simple robot joint model?
- Creating shapes for each link
  - Grouping each link's components
  - Inserting a pivot axis for joint rotation
  - Programming microcontroller code within Tinkercad's interface

Ans :

MAIN 2016

- (d) Programming microcontroller code within Tinkercad's interface

Tinkercad's 3D design environment focuses on geometric modeling and alignment. It does not directly provide a programming interface for microcontrollers (though Tinkercad Circuits can simulate basic electronics separately). Creating shapes, grouping parts, and defining a pivot are standard steps for mechanical visualization.

26. The motion of a revolute joint is often limited in real robots to protect components. In Tinkercad, you would likely :
- Add advanced servo electronics code
  - Manually rotate the link within a safe angle range
  - Apply physical damping tools automatically
  - Use built-in stress sensors

Ans :

SQP 2013

- (b) Manually rotate the link within a safe angle range

Tinkercad lacks sophisticated servo or damping modules. You simply rotate parts in the design environment to approximate real-world constraints. Users visually confirm that the motion stays within feasible angles, ensuring the design doesn't exceed physical limits or cause collisions.

27. Which of the following best describes "visualizing motion" in Tinkercad for an RR arm?

- Moving the entire arm as one rigid part
- Rotating each revolute joint individually to see various poses
- Programming forward kinematics in Tinkercad code
- Calculating torque demands at each joint

Ans :

COMP 2019

- (b) Rotating each revolute joint individually to see various poses

In Tinkercad, you separate each link at the pivot point, manually "rotate" them to evaluate the arm's possible positions. Detailed forward kinematics, torque calculations, or coding must be done externally. "Visualizing motion" is a straightforward, manual manipulation of the virtual parts.

28. What does the notation "RR" specifically tell us about a robotic mechanism?
- It has two prismatic joints
  - It has two rotational joints in sequence
  - It uses a rack and pinion system
  - It employs only linear actuators

Ans :

MAIN 2015

- (b) It has two rotational joints in sequence  
"RR" is standard shorthand for a two-link serial chain with each joint being revolute. This provides two rotational degrees of freedom, allowing the arm to pivot in a plane. Other notations might be "R-P," "P-P," etc., depending on whether joints are rotational or prismatic.

29. When designing in Tinkercad, a good practice to ensure correct joint alignment is to \_\_\_\_\_.
- Randomly place parts so they overlap
  - Use a measuring tape in real life only
  - Utilize the "Align" and "Snap" tools to position pivot axes precisely
  - Skip alignment and finalize after 3D printing

Ans :

SQP 2012

- (c) Utilize the "Align" and "Snap" tools to position pivot axes precisely

Correct alignment ensures that when the joint rotates, it accurately matches the intended pivot. Tinkercad's "Align" and "Snap" tools help place shapes at precise coordinates, matching axes for rotational or linear motion. Random placement or skipping alignment can lead to flawed designs or collision problems.

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- 30.** Why is an RR mechanism suited for planar tasks?
- Each joint offers infinite linear extension
  - Two revolute joints combined allow sweeping arcs in 2D space
  - It requires no motors
  - It includes ball-and-socket motion for 3D angles

Ans :

COMP 2006

(b) Two revolute joints combined allow sweeping arcs in 2D space

With two rotational joints, an RR arm can pivot each segment, covering a plane of reachable points. It forms arcs as each joint independently rotates. This is sufficient for many 2D tasks. Adding more joints or different joint types can increase the arm's workspace to 3D or more complex motions.

- 31.** A university robotics team is developing a mobile robot for indoor navigation. In designing the robot's structure, they focus on its mechanical block.

Which element does the mechanical block primarily include?

- Only software algorithms
- Electronic control circuits
- Structural and moving components, including actuators and sensors
- External aesthetics only

Ans :

MAIN 2011

(c) Structural and moving components, including actuators and sensors

In this case, the robotics team's mobile robot depends on its mechanical block, which comprises all structural and moving parts including frames, actuators, and sensors. These components provide the robot's physical form and precise motion capabilities, ensuring integration with control systems for effective performance in navigating complex indoor environments efficiently.

- 32.** A startup design team is prototyping components for a new robot using an online CAD tool. They need an accessible platform to visualize their parts before fabrication. Which CAD tool is mentioned for visualizing and prototyping robotic parts?
- SolidWorks
  - Tinkercad
  - AutoCAD
  - Blender

Ans :

SQP 2018

(b) Tinkercad

In this scenario, the design team uses Tinkercad as their primary CAD tool. Tinkercad offers a browser-based platform for creating and visualizing 3D models, facilitating rapid prototyping of robotic components. This software enables early detection of design errors, saving time and costs before manufacturing physical parts, ensuring robust rapid development.

- 33.** At a manufacturing plant, engineers install a new joint in a robotic arm used for assembly tasks. They require precise rotation at the joint for effective component placement.

Which joint type provides rotational motion around a fixed axis?

- Prismatic Joint
- Revolute Joint
- Spherical Joint
- Universal Joint

Ans :

COMP 2014

(b) Revolute Joint

In the manufacturing plant, the robotic arm incorporates revolute joints to provide controlled rotational motion around fixed axes. This design enables precise angular movements necessary for complex assembly tasks. Revolute joints, marked as "R" in kinematic notation, ensure smooth operation and reliable performance in dynamic robotic applications under heavy load.

- 34.** A factory is developing a gantry robot for material handling that must move components along a straight path with high precision.

Which joint type enables linear, sliding motion in robotic systems?

- Revolute Joint
- Prismatic Joint
- Spherical Joint
- Cylindrical Joint

Ans :

MAIN 2009

(b) Prismatic Joint

In this case, the factory employs prismatic joints in its gantry robot to achieve accurate linear sliding motion. Prismatic joints, symbolized by "P" in kinematic notation, allow straightforward displacement required for precise positioning. Their integration ensures consistent performance and reliability in manufacturing processes needing exact linear adjustments with minimal error.

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- 35.** An engineering team is building a prototype planar robotic arm for a demonstration. They require a mechanism that allows the arm to sweep a 2D area.

An RR mechanism in a robotic arm consists of which configuration of joints?

- (a) Two prismatic joints
- (b) One revolute and one prismatic joint
- (c) Two revolute joints
- (d) One revolute and one spherical joint

**Ans :**

SQP 2017

- (c) Two revolute joints

In the prototype demonstration, the engineering team utilizes an RR mechanism in the planar robotic arm. This configuration consists of two revolute joints arranged sequentially, allowing the arm to sweep a two-dimensional plane. Such an arrangement provides flexible angular movement and precise control, essential for effective task execution with efficiency.

- 36.** A robotics startup is testing a newly designed joint using Tinkercad to simulate its movement before physical production.

Why is visualization using CAD tools like Tinkercad important in robot design?

- (a) To reduce material cost only
- (b) To understand joint motion and detect design flaws
- (c) To simulate electronic circuitry
- (d) To replace physical fabrication completely

**Ans :**

SQP 2007

- (b) To understand joint motion and detect design flaws

In this case, the startup employs Tinkercad for CAD-based visualization, enabling designers to simulate joint motion and identify potential design flaws. Early error detection optimizes the design process, minimizes production costs, and ensures that the final robotic assembly functions smoothly with verified geometry and reliable movement during real-world operation efficiently.

- 37.** A design engineer preparing for a robotics competition is selecting materials for a new lightweight chassis that must be durable yet easy to move.

Why must material considerations in robotic design emphasize strength and lightweight properties?

- (a) To increase weight only
- (b) To enhance durability and ease of movement

- (c) To simplify electronic integration
- (d) To avoid using sensors

**Ans :**

COMP 2008

(b) To enhance durability and ease of movement  
In this competition scenario, material selection is critical as the robotic chassis must be both strong and lightweight. This balance enhances durability while ensuring ease of movement. Optimal material properties reduce energy consumption and improve performance, offering a competitive edge through reliable structure and agile maneuverability in dynamic environments effectively.

- 38.** During the design phase of a new robotic arm, engineers use Tinkercad to verify that pivot points are correctly aligned for realistic motion simulation.

How does Tinkercad assist designers in robotic component development?

- (a) By providing advanced physics simulation
- (b) By enabling 3D model creation and basic motion simulation
- (c) By controlling actuators directly
- (d) By automating material selection

**Ans :**

MAIN 2010

- (b) By enabling 3D model creation and basic motion simulation

In this instance, engineers utilize Tinkercad to create detailed 3D models of robotic components and simulate basic motion. This process verifies proper pivot alignment, detects potential design errors, and optimizes dimensions. Early simulation using Tinkercad reduces development time and production costs while ensuring accurate, functional robotic assemblies with high precision.

- 39.** A robotics engineer is integrating various sensors and actuators in a new platform to improve performance on complex tasks.

What role does the controller play in the mechanical subsystem of robotics?

- (a) It provides the physical structure
- (b) It processes sensor feedback and commands actuators
- (c) It designs CAD models
- (d) It determines material properties

**Ans :**

SQP 2022

- (c) It processes sensor feedback and commands actuators

In this integration scenario, the controller is critical as it receives sensor inputs, compares them with setpoints, and commands actuators accordingly. This closed-loop system ensures accurate motion control and adaptive responses. The controller synchronizes mechanical components and sensor feedback, forming the backbone of efficient robotic operation and performance with consistent reliability.

- 40.** A university research team is prototyping a robotic arm using Tinkercad to simulate joint rotations and verify movement ranges before building the physical model.

In designing a robotic arm with Tinkercad, why is proper alignment of pivot points crucial?

- (a) To enhance aesthetics
- (b) To ensure accurate simulation of motion
- (c) To simplify sensor integration
- (d) To increase weight capacity

**Ans :**

COMP 2023

- (b) To ensure accurate simulation of motion

In this research project, correct pivot point alignment in Tinkercad is essential for simulating realistic joint rotations. Proper alignment prevents design errors, avoids collisions, and verifies the range of motion. Accurate simulation before fabrication saves time and resources, ensuring that the physical prototype performs as intended with optimal functionality effectively.

- 41.** Which statement correctly describes Tinkercad's primary function in robotic design?

- (a) Tinkercad automatically codes microcontrollers.
- (b) Tinkercad provides full dynamic stress analysis.
- (c) Tinkercad is a 3D modeling tool useful for basic motion visualization.
- (d) Tinkercad only supports 2D geometric sketches.

**Ans :**

MAIN 2024

- (c) Tinkercad is a 3D modeling tool useful for basic motion visualization.

Tinkercad is well-known for its straightforward 3D modeling and rudimentary motion checks. It doesn't generate microcontroller code or advanced physics simulations, nor is it limited to 2D. The correct statement highlights its role in conceptual modeling and simple rotation/translation visualization.

- 42.** Select the correct statement about revolute and prismatic joints.

- (a) Revolute joints rotate about an axis; prismatic joints slide linearly.
- (b) Both revolute and prismatic joints refer to rotational axes.
- (c) Revolute joints provide linear motion, while prismatic joints rotate.
- (d) Prismatic joints are never used in real robots.

**Ans :**

SQP 2013

- (a) Revolute joints rotate about an axis; prismatic joints slide linearly.

A revolute joint rotates about a pivot, similar to a hinge, while a prismatic joint extends or retracts linearly. The other statements are incorrect or too absolute. Prismatic joints are indeed used in robotics, just not for rotational movement.

- 43.** Which statement about the RR mechanism is correct?

- (a) It employs two prismatic slides for 2D movement.
- (b) It combines a prismatic and a revolute joint.
- (c) It uses two revolute joints in series, providing planar rotation.
- (d) It is not used in robotics.

**Ans :**

COMP 2016

- (c) It uses two revolute joints in series, providing planar rotation.

"RR" indicates two revolute joints in a chain, giving a planar robotic arm the ability to rotate at each segment. This arrangement is common in basic robotic arms. The other statements wrongly describe P joints or claim the mechanism is not used, which is inaccurate.

- 44.** Which statement best explains how Tinkercad helps in the mechanical block design process?

- (a) It interprets sensor data for the robot's AI system.
- (b) It allows users to draw, align, and rotate shapes to conceptualize robotic parts.
- (c) It simulates advanced torque and load conditions.
- (d) It is only used for circuit wiring simulations.

**Ans :**

MAIN 2015

- (b) It allows users to draw, align, and rotate shapes to conceptualize robotic parts.

Tinkercad enables creating and manipulating 3D shapes, grouping components to form links or brackets, and visualizing how joints move. This

basic level of 3D modeling is essential for early-stage mechanical block design. Advanced torque analysis or AI sensor data interpretation are beyond Tinkercad's scope.

45. Which statement about the mechanical block in robotics is correct?
- It only includes microcontrollers and wiring.
  - It deals with software algorithms primarily.
  - It consists of the robot's structure, joints, and transmission elements.
  - It has no moving parts.

Ans :

SQP 2019

(c) It consists of the robot's structure, joints, and transmission elements.

The mechanical block comprises the physical structure—frames, joints, gears, linkages, etc.—that enables robotic motion. Microcontrollers, wiring, and software are part of the electrical/control blocks. Hence, statement (c) accurately captures the mechanical block's elements, which definitely include moving parts and linkages.

46. Which statement correctly describes a prismatic joint?
- It adds rotational degrees of freedom
  - It has a sliding or telescoping motion.
  - It is identical to a ball-and-socket joint
  - It can pivot in multiple planes

Ans :

MAIN 2006

(b) It has a sliding or telescoping motion.

Prismatic joints provide linear motion along a single axis, typically resembling a sliding or telescoping action. They do not pivot in multiple planes; that is characteristic of ball-and-socket or universal joints. Thus, statement (b) accurately identifies the fundamental nature of a prismatic joint.

47. Which statement about Tinkercad's motion visualization is correct?
- It shows real-time reaction forces from collisions
  - It allows basic rotation/translation of parts to check alignments
  - It automatically calculates motor speeds and acceleration
  - It can run advanced time-step simulations with friction

Ans :

SQP 2012

(b) It allows basic rotation/translation of parts to check alignments

Tinkercad's main advantage is the ability to move parts around pivot points or along axes. This simple approach checks if components align and fit properly. The platform does not handle real-time collision physics, friction, or advanced calculations, thus statement (b) captures the correct functionality.

48. Identify the correct statement about an RR robotic arm design.
- Each joint is prismatic, offering 2D sliding
  - It combines a rotary joint with a prismatic one
  - It can revolve at both joints, covering a plane of motion
  - It offers no motion if any joint is locked

Ans :

COMP 2018

(c) It can revolve at both joints, covering a plane of motion

The "RR" arm has two revolute joints, each rotating in a plane, giving two degrees of freedom. Hence, it can sweep various positions in that plane. Prismatic joints would yield linear motion, and if a joint is locked, partial motion might remain—so statement (c) is best.

49. Which statement about designing robotic components in Tinkercad is correct?
- The software requires advanced engineering degrees to use
  - It is free, web-based, and suitable for simple 3D modeling of parts
  - It offers integrated final manufacturing
  - It simulates circuit code in the same interface as 3D designs

Ans :

MAIN 2011

(b) It is free, web-based, and suitable for simple 3D modeling of parts

Tinkercad is publicly accessible, browser-based, and user-friendly, suitable for beginners and hobbyists. While it has a separate module for basic circuit simulation, it doesn't merge them into one advanced environment. It definitely doesn't require advanced degrees to operate. Thus, statement (b) is correct.

50. Which statement correctly distinguishes revolute joints from prismatic joints?
- Revolute joints rotate, prismatic joints slide.
  - Both revolve around a single pivot.
  - Both provide linear actuation only.
  - Revolute joints move in a straight line.

Ans :

SQP 2009

(a) Revolute joints rotate, prismatic joints slide. Revolute joints rotate about an axis; prismatic joints translate linearly. This fundamental difference separates the two main mechanical joint types in robotics. The other statements either confuse or invert these definitions. Hence, statement (a) is the succinct, correct distinction.

## ASSERTION AND REASON

**51. Assertion (A) :** Revolute joints allow rotation about a fixed axis.

**Reason (R) :** Prismatic joints provide linear sliding motion.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(b) Both Assertion and Reason are correct, but Reason is not the correct explanation. Both statements are correct : revolute joints rotate, prismatic joints slide. However, the reason does not explain why revolute joints allow rotation. It only states a different fact about prismatic joints. Hence, while both are true, the reason is not explaining the assertion.

**52. Assertion (A) :** Tinkercad is ideal for performing advanced finite element analysis (FEA) on robot arms.

**Reason (R) :** Tinkercad mainly focuses on simple 3D design and basic visualization.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect; Tinkercad is not designed for advanced FEA. The reason is correct—Tinkercad is more of a simple modeling

tool. Therefore, the correct choice is (D) : the assertion is wrong, but the reason correctly summarizes Tinkercad's actual capability.

**53. Assertion (A) :** An RR mechanism is well-suited for planar movements.

**Reason (R) :** Two revolute joints in series can pivot each link, allowing the arm to sweep a 2D plane.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both the assertion and reason are correct, and the reason perfectly explains why an RR mechanism is suitable for planar movement. Each link can rotate in the same plane, enabling coverage of a flat, two-dimensional workspace.

**54. Assertion (A) :** Prismatic joints in a robot arm enable rotational motion around a pivot.

**Reason (R) :** Prismatic joints are responsible for linear translation in a single direction.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because prismatic joints do not rotate; they translate linearly. The reason is correct : prismatic joints allow sliding along one axis. Thus, the assertion contradicts the known definition, while the reason accurately states prismatic joints' function.

**55. Assertion (A) :** The mechanical block of a robot can be designed and previewed in Tinkercad before fabrication.

**Reason (R) :** Tinkercad offers a user-friendly interface for 3D modeling and basic motion visualization.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are true and logically connected. Because Tinkercad is indeed easy to use for basic 3D design and motion checks, one can design and preview mechanical elements prior to physical building. Hence, the reason clarifies why the assertion holds.

- 56. Assertion (A) :** An RR arm has only linear movement.

**Reason (R) :** Each “R” in RR denotes a revolute joint providing rotational motion.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because an RR arm is purely rotational, not linear. The reason is correct : each “R” stands for a revolute joint. Therefore, the correct answer is (D) since the reason contradicts the incorrect assertion and provides the accurate description.

- 57. Assertion (A) :** Tinkercad includes a built-in microcontroller code compiler.

**Reason (R) :** Tinkercad Circuits can simulate basic electronics and Arduino code.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(c) Assertion is correct, but Reason is incorrect. The assertion is not entirely correct if we speak specifically of the Tinkercad 3D design

environment—there is no built-in code compiler for robotics. However, Tinkercad Circuits, a separate module, can simulate Arduino code. So the assertion is incorrect regarding the 3D environment, but the reason references a separate feature.

- 58. Assertion (A) :** Revolute joints are more common than prismatic joints in most industrial robot arms.

**Reason (R) :** Many tasks require multi-axis rotation rather than simple linear extension.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Industrial arms often mimic human-like rotation for flexible tasks, hence more revolute joints. The reason accurately explains that rotational movement is typically needed (e.g., picking, placing at varied angles). Thus, both statements are correct, and the reason logically explains the assertion.

- 59. Assertion (A) :** Visualization of a joint’s motion helps identify if the design can physically pivot without interference.

**Reason (R) :** CAD tools like Tinkercad allow rotation of parts around pivot points, revealing any collisions in the model.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both assertion and reason are correct, and the reason directly explains how motion visualization identifies potential interference. By rotating parts in Tinkercad, designers can see if they overlap or collide. This is precisely why visualization is a key step before finalizing mechanical design.

- 60. Assertion (A) :** Prismatic joints are never used in robotics due to lack of rotation.

**Reason (R) :** Some robotic systems, such as Cartesian or gantry robots, rely solely on linear (prismatic) axes.

**Options**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect; prismatic joints are indeed used, especially in Cartesian robots. The reason is correct : certain robot types (3-axis gantry, for example) employ only prismatic motion. Thus, the assertion is wrong, but the reason is valid and clarifies prismatic usage.

## STATEMENT BASED QUESTIONS

- 61.** Consider the following statements about the definition and purpose of the mechanical block of robotics :

- 1. The mechanical block includes all structural and moving components of a robot.
  - 2. It houses actuators and sensors and ensures precise motion, whether rotational or linear.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct. The material explains that the mechanical block (or subsystem) encompasses all structural and moving parts, and it also houses actuators and sensors to ensure precise motion.

- 62.** Consider the following statements about the use of CAD tools in designing robotic components :

- 1. CAD tools like Tinkercad and Fusion 360 help visualize and prototype robot parts.
  - 2. CAD-based visualization does not assist in detecting dimensional or alignment errors before building physical prototypes.
- (a) Only statement 1 is correct.

- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Statement 1 is accurate because CAD tools are used to design and prototype parts. Statement 2 is incorrect since one major benefit of CAD-based visualization is to detect errors early, thus saving time and cost.

- 63.** Consider the following statements about common robotic components and material considerations :

- 1. Common robotic components include frames, arms, joints, and end-effectors (such as grippers or tools).
  - 2. Material considerations for robot components always prioritize heavy metals for maximum durability.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Statement 1 is correct as the text lists these components. Statement 2 is false because the materials used must be strong yet lightweight; designers often choose plastics or lightweight metals rather than heavy metals exclusively.

- 64.** Consider the following statements regarding Tinkercad for 3D design :

- 1. Tinkercad is a simple, browser-based platform that allows users to create 3D models for robotic parts.
  - 2. Tinkercad automatically provides advanced physics simulation to fully replicate real-world robot dynamics.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Tinkercad is indeed a browser-based tool used for creating 3D models. However, it does not offer advanced physics simulation; users must manually rotate components to visualize motion.

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**65.** Consider the following statements about revolute joints in robotics :

1. Revolute joints provide rotational motion around a fixed axis.
  2. They are commonly used in robotic arms and are symbolized as R in kinematic notation.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.  
 Both statements correctly describe revolute joints : they provide rotation and are typically denoted by “R” in kinematic notation.

**66.** Consider the following statements about prismatic joints in robotics :

1. Prismatic joints provide linear (sliding) motion.
  2. They are often used in Cartesian or gantry robots and are symbolized as P in kinematic notation.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.  
 The material clearly states that prismatic joints offer linear motion and are denoted as “P,” commonly used in Cartesian/gantry systems.

**67.** Consider the following statements regarding the RR Mechanism :

1. An RR Mechanism is a two-joint robotic linkage consisting of two revolute joints in sequence.
  2. It is typically used in planar robotic arms to sweep a 2D plane by changing angles at two revolute connections.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.  
 Both statements correctly describe an RR Mechanism : it consists of two revolute joints and is used in planar arms for 2D motion.

**68.** Consider the following statements about the importance of visualization in robotic design :

1. Visualization helps in understanding how each joint moves and in identifying potential collisions or design flaws.
  2. Visualization is not important since errors in dimensions or alignment can be corrected after physical fabrication.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.  
 Statement 1 is correct because visualization allows designers to foresee and correct errors before building physical prototypes. Statement 2 is incorrect since early visualization is critical to avoid costly mistakes.

**69.** Consider the following statements regarding the use of Tinkercad to visualize motion :

1. In Tinkercad, each link of a robotic component can be modeled as a separate part and aligned with designated pivot points to simulate movement.
  2. Tinkercad offers advanced physics simulation that automatically replicates all aspects of real-world motion dynamics.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.  
 Statement 1 accurately describes how Tinkercad can be used to assemble parts and simulate basic motion by manually rotating components. Statement 2 is false because Tinkercad does not offer a full-scale physics simulation.

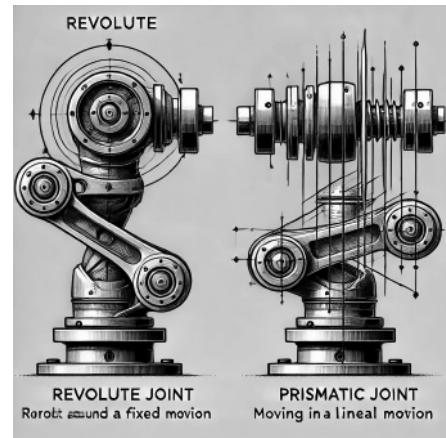
**70.** Consider the following statements about the benefits of CAD-based visualization in robotics :

1. CAD-based visualization helps detect errors in dimensions and alignment early in the design process.
2. It enables efficient adjustments of design parameters (such as lengths, angles, and hole placements) to save time and cost before building physical prototypes.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

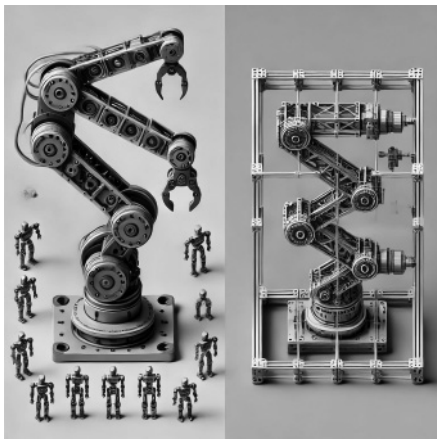
Ans :

(c) Both statements 1 and 2 are correct.  
Both statements accurately capture the benefits of using CAD-based visualization, which include early error detection and efficient design adjustments that reduce time and cost in prototyping.



## PICTURE BASED QUESTIONS

71. Observe the images :



Which of the following is true?

- (a) Both are mechanical blocks, but only the first enables motion.
- (b) Neither plays a role in robotics.
- (c) The second image represents an actuator system.
- (d) The first image is not part of a robot.

Ans :

(a) Both are mechanical blocks, but only the first enables motion.  
The mechanical block of a robot includes both static (frames) and dynamic (joints, actuators) components. The robotic arm in the first image includes moving parts, while the second is only a structural frame.

72. Look at the images :

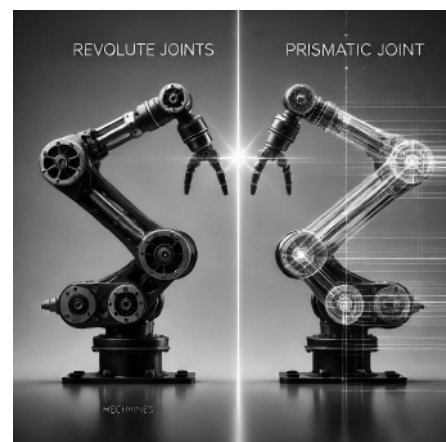
What types of joints are shown?

- (a) Prismatic and revolute, respectively.
- (b) Both are revolute joints.
- (c) Revolute and prismatic, respectively.
- (d) Neither are robot joints.

Ans :

(c) Revolute and prismatic, respectively.  
Revolute joints provide rotational motion (e.g., robotic arm joints). Prismatic joints enable linear motion (e.g., sliding components in Cartesian robots).

73. Consider the images :



Which statement is correct?

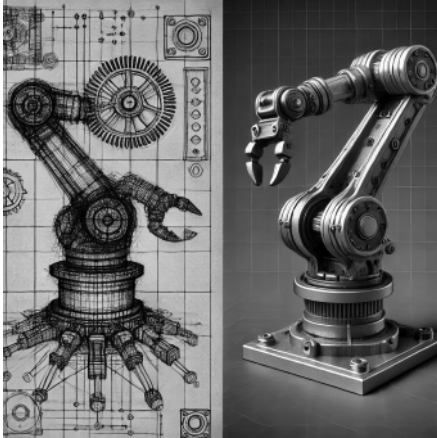
- (a) The first system follows an RR mechanism.
- (b) The second system is an RR mechanism.
- (c) Both systems use only prismatic joints.
- (d) The first system does not involve rotational motion.

Ans :

(a) The first system follows an RR mechanism.  
RR mechanisms consist of two revolute joints (e.g., robotic arms with two rotational links).

The second system uses prismatic motion, which doesn't classify as RR.

74. Look at the images :



Why is CAD-based visualization important?

- (a) It helps in identifying errors before physical fabrication.
- (b) It only adds extra steps to robot development.
- (c) It is not useful for robotic design.
- (d) Sketching provides the same accuracy as CAD modeling.

Ans :

- (a) It helps in identifying errors before physical fabrication.
- CAD tools allow designers to visualize movement, check clearances, and detect errors early in the design phase, reducing costs and improving efficiency.

## TWO MARKS QUESTIONS

75. Define a revolute joint with one real-life example.

Ans :

MAIN 2025

A revolute joint is a pivot that rotates around a single axis, like a door hinge. In robotics, an example is an elbow joint in a robotic arm, allowing angular movement.

76. How does Tinkercad help in conceptualizing a robot's mechanical design?

Ans :

SQP 2022

Tinkercad enables users to create 3D shapes, align them into assemblies, and manually test basic rotations or translations. This quick visualization

ensures components fit together and move as intended.

77. What is the significance of the mechanical block in robotics?

Ans :

COMP 2008

It forms the physical framework, housing joints and linkages that convert actuator power into motion. Without it, a robot cannot perform tangible tasks or maintain structural stability.

78. Give one advantage of using an RR mechanism in planar tasks.

Ans :

MAIN 2010

Two revolute joints let the arm rotate both segments independently, covering a wide 2D workspace. This flexibility is ideal for tasks like picking and placing on a flat surface.

79. Differentiate between revolute and prismatic joints in a single sentence.

Ans :

SQP 2017

Revolute joints rotate about a pivot, while prismatic joints slide linearly along an axis.

80. Mention one purpose of visualizing motion in CAD software.

Ans :

COMP 2007

To ensure that parts do not collide and that each joint can achieve its intended range of motion before manufacturing.

81. Name two robot parts you might design in Tinkercad.

Ans :

MAIN 2014

Examples include the arm segment (link) and a gripper claw. These parts can be individually modeled for size, shape, and connection points.

82. Why might an engineer opt for prismatic joints in a robot's design?

Ans :

SQP 2009

Prismatic joints are ideal for straight-line tasks—like lifting, sliding, or adjusting height—often seen in pick-and-place or vertical milling machine setups.

83. Explain “RR mechanism” in the context of robotic arms.

Ans :

COMP 2006

It's a two-link system, each link connected by a revolute (rotational) joint, allowing an arm to rotate both segments in a plane for versatile positioning.

- 84.** State one common limitation of Tinkercad in robotic design.

**Ans :** MAIN 2012

It lacks advanced physics or stress analysis, so it cannot accurately predict loads or motor torque requirements—engineers must use more specialized tools for that.

- 85.** How does a revolute joint differ from a ball-and-socket joint?

**Ans :** SQP 2018

A revolute joint rotates around one axis only, whereas a ball-and-socket joint can rotate in multiple directions, providing additional degrees of freedom.

- 86.** What is the role of alignment tools in Tinkercad?

**Ans :** COMP 2011

They ensure components line up correctly, placing pivot points or slides precisely so the assembled model reflects the intended real-world design.

- 87.** Give one example of a purely prismatic robot.

**Ans :** MAIN 2019

A typical Cartesian or gantry robot, which uses multiple linear slides (x, y, z), is purely prismatic in each axis.

- 88.** Why is the mechanical block crucial for a robot's performance?

**Ans :** SQP 2015

It determines how effectively the robot's actuators translate power into movement, influencing speed, precision, and load capacity.

- 89.** How might Tinkercad's "Group" function assist in designing a robotic part?

**Ans :** COMP 2016

It merges multiple shapes into one solid model, simplifying manipulation and ensuring consistent movement or alignment when repositioning the entire part.

- 90.** Give an example scenario where RR joints are insufficient.

**Ans :**

MAIN 2013

Tasks requiring 3D movement or rotation about an additional axis (like twisting) need more degrees of freedom (e.g., RRR or RRP arms), making RR alone insufficient.

- 91.** What is the main goal of "visualizing motion" before final assembly?

**Ans :** SQP 2025

To confirm that the design operates as planned—no collisions or mechanical interference—and each joint's range is sufficient.

- 92.** Mention a practical application for a prismatic joint in an industrial setting.

**Ans :** COMP 2021

Automated storage systems use prismatic lifts to move shelves or products vertically along a single linear axis.

- 93.** Define a mechanical linkage.

**Ans :** MAIN 2023

It's a collection of rigid bodies (links) connected by joints, arranged to transfer or transform motion and force within a mechanism.

- 94.** Why might you combine revolute and prismatic joints in one robot?

**Ans :** SQP 2024

Mixing R and P joints offers both rotation and linear travel, enabling more complex movements—ideal for tasks requiring a wide range of motion and positioning.

## THREE MARKS QUESTIONS

- 95.** Explain how Tinkercad aids in the preliminary design of a robot's mechanical block.

**Ans :** MAIN 2025

Tinkercad lets designers create and align 3D shapes for the robot's structural parts—like links, joints, or frames. By simulating simple rotations or translations, one can catch alignment errors early. This speeds up the iterative design process before moving to complex CAD or physical prototyping.

- 96.** Describe the key difference between a single revolute joint and an RR mechanism in terms of degrees of freedom (DOF).

**Ans :** SQP 2019

A single revolute joint grants one rotational DOF about its axis. An RR mechanism has two consecutive revolute joints, meaning two rotational DOFs—enabling an arm to change orientation at each joint and reach a broader set of positions in its plane of motion.

- 97.** Why do engineers often use prismatic joints in Cartesian robots?

**Ans :** COMP 2006

Cartesian robots need straightforward, perpendicular translations along x, y, and z axes. Prismatic joints excel at linear motion, aligning well with that coordinate-based approach. This simplifies programming, as each axis corresponds directly to a prismatic slide.

- 98.** How does using Tinkercad’s ‘Align’ tool improve the accuracy of a joint design?

**Ans :** MAIN 2017

The “Align” tool ensures that parts intended to share a pivot are perfectly centered or arranged. If two shapes must rotate around the same axis, aligning them precisely avoids offset angles or collisions. This eliminates guesswork, leading to a more realistic model of the intended mechanism.

- 99.** Discuss one benefit and one limitation of using Tinkercad for robotic joint visualization.

**Ans :** SQP 2010

**Benefit :** Rapidly testing different component sizes and orientations to confirm feasibility without cost-intensive prototypes.

**Limitation :** Lack of advanced motion physics—e.g., friction, inertia, or stress—meaning real-world performance might differ from the simplistic visualization.

- 100.** Explain how an RR mechanism achieves planar movement using two revolute joints.

**Ans :** COMP 2024

Each revolute joint pivots around its own axis, cumulatively letting the arm sweep across a plane. The first rotation sets the base angle, while the second changes the relative angle of the next link. Combining both angles positions the end-effector

anywhere in that 2D workspace.

- 101.** Why might a designer create both revolute and prismatic joints in a single robotic system?

**Ans :** MAIN 2013

Combining R and P joints yields more versatile motion—rotational for orientation changes and linear for extension. For instance, a robotic arm might rotate to a position (via revolute joints) and then move straight out (via prismatic) to reach a part without changing orientation.

- 102.** Describe the process of grouping shapes in Tinkercad to form a single part of a robot arm.

**Ans :** SQP 2011

First, the user arranges basic shapes (e.g., cylinders, boxes) to match the desired geometry of the arm segment. Then, using Tinkercad’s “Group” command, these shapes merge into one continuous object. This part can then be rotated or positioned as a single entity, simplifying design steps.

- 103.** In what way does a prismatic joint’s motion differ from a revolute joint’s in terms of designing limits and safety stops?

**Ans :** COMP 2009

Prismatic joints require linear constraints—stops at minimum and maximum extension to prevent overtravel. Revolute joints need angular limits (e.g., 0° to 180°). The methods differ because prismatic motion is measured in linear distance, whereas revolute motion is controlled by angular displacement.

- 104.** How do mechanical linkages within the mechanical block translate actuator power into effective end-effector motion?

**Ans :** MAIN 2022

Actuators (motors or cylinders) apply force or torque to one link, which transfers movement through joints or gears to subsequent links. This chain reaction amplifies, modifies, or reorients the motion until it reaches the end-effector, enabling tasks like lifting, grasping, or positioning.

- 105.** Discuss how Tinkercad’s simplicity can be both an advantage and a disadvantage in robotics design.

**Ans :** SQP 2023

**Advantage :** The intuitive interface is excellent for quick, conceptual modeling—especially for

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beginners or early-stage brainstorming.

Disadvantage : It lacks advanced simulation tools (stress, kinematics, dynamic collisions), forcing engineers to switch to more robust software for detailed analyses.

- 106.** Compare the motions achievable by an RR arm with those of a single prismatic joint.

Ans :

COMP 2016

An RR arm can sweep a broad arc or circle in a plane, adjusting angles at each joint. A single prismatic joint only extends or retracts along one linear path. Thus, the RR arm offers a more complex range of motion within two rotational degrees of freedom.

- 107.** Why is it important to visualize mechanical parts before purchasing or fabricating them?

Ans :

MAIN 2015

Visualization helps catch errors or collisions, verify correct dimensions, and identify potential improvements. Addressing these issues at the CAD stage reduces wasted materials, saves time, and curbs manufacturing costs by ensuring a higher likelihood of a correct first-build outcome.

- 108.** How might a designer utilize Tinkercad's basic pivot feature to test an RR mechanism's range of motion?

Ans :

SQP 2012

They could place each link's pivot axis at the joint location, then manually rotate each link through its plausible angles. Observing the positions of the second link at each step helps ensure the combined angles deliver the desired workspace without overlapping or misalignment.

- 109.** Explain how adding a prismatic joint can enhance the reach of a planar RR arm.

Ans :

COMP 2018

After the two revolute joints, a prismatic joint could extend the end-effector linearly outward, allowing the arm to cover additional distance. This combination merges rotation for angular positioning with linear extension, improving workspace coverage in tasks requiring variable reach.

- 110.** Describe one real-world scenario where a pure R-R arm is sufficient.

Ans :

MAIN 2014

A small assembly station that picks parts off a conveyor (within a 2D plane) and places them slightly to the side can use an RR arm. Rotational motion around two pivots is enough to reach all relevant points in that plane.

- 111.** What preliminary checks can be done using Tinkercad to ensure a mechanical design is feasible?

Ans :

SQP 2007

Designers can confirm part sizes, ensure joints pivot without collision, and visualize approximate angles or extension. Basic alignment is also examined, ensuring the final assembly is dimensionally coherent before more detailed engineering or physical prototyping.

- 112.** How does the mechanical block integrate with the electronics block in a robot?

Ans :

COMP 2022

The mechanical block provides the physical means to execute movements, while the electronics block (controllers, sensors, power) drives and monitors these motions. Actuators receive signals from the controller to move joints, and sensors feed back data, creating a fully functional mechatronic system.

- 113.** Why is the "R" in RR considered a single degree of freedom, and what does this imply for the entire RR system?

Ans :

MAIN 2025

Each revolute joint allows rotation around only one axis, representing one DOF. Therefore, an RR system totals two DOF. The arm can pivot in two places, enabling more complex paths than a single joint but fewer than arms with more DOFs.

- 114.** In designing a robotic gripper with Tinkercad, how might you illustrate the "open-close" motion?

Ans :

SQP 2021

Model each finger as a separate segment attached by a revolute pivot. Manually rotate fingers outward to show "open" and inward to simulate "close." This reveals if the fingers overlap or leave gaps when gripping an object of specified size.

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## CASE BASED QUESTION

- 115.** You are designing a 2-link planar arm (RR) in Tinkercad to pick small items off a conveyor belt. How would you confirm that the arm can reach every point on the conveyor's width?

**Ans :**

1. Create each link in Tinkercad, define pivot points for the two revolute joints.
2. Manually rotate each joint through its range to see if the end-effector covers the conveyor's entire width.
3. Adjust link lengths or pivot angles if you find unreachable spots.

- 116.** A small workshop wants a simple sliding mechanism to push items off a table. Which joint type is most suitable, and how might you visualize it in Tinkercad?

**Ans :**

1. A prismatic (P) joint is ideal for straight-line pushing.
2. In Tinkercad, model a "slider" block and a "rail" or "track." Slide the block linearly to confirm the extension needed to push items off the table.
3. Check for collisions with other components.

- 117.** You must design a robotic gripper with two fingers that pivot closed. In Tinkercad, how would you demonstrate that the gripper can hold an object of a certain diameter?

**Ans :**

1. Build each finger segment as a separate piece, attach them with revolute pivots at the "knuckle."
2. Position a cylindrical shape representing the object's diameter.
3. Rotate each finger to "close" around the cylinder, ensuring they fit securely without overlapping or leaving excessive gaps.

- 118.** A user complains that their RR arm design collides at certain angles. Which Tinkercad feature or technique would help identify and fix the collision points?

**Ans :**

1. Manual Rotation : Incrementally rotate each joint in Tinkercad to detect the exact angle causing overlap.

2. Align and Inspect : Adjust pivot placement or reduce link sizes.
3. Possibly "Hide" or "Transparent" certain parts to visualize internal collisions.

- 119.** You plan to create a small drawbridge-like mechanism that lifts up a platform. What joint type does this describe, and how would Tinkercad modeling assist in verifying clearances?

**Ans :**

1. A revolute joint near one end of the platform (like a hinge).
2. In Tinkercad, place a pivot at the hinge side, then rotate the platform "up" to ensure nothing obstructs its movement.
3. Confirm the angle is sufficient for desired clearance.

- 120.** A school project requires building a Cartesian robot to move an object along x and y axes. How do prismatic joints in Tinkercad illustrate this motion?

**Ans :**

1. Model each axis as a separate sliding rail.
2. For x-motion, a block slides on the horizontal rail; for y-motion, that entire rail (or a second block) moves vertically.
3. Manually shift each rail to confirm the total reachable workspace on the 2D plane.

- 121.** You want an RR arm to lift an object from a tray (far away) to a basket (closer). How would you test this in Tinkercad to ensure both positions are reachable?

**Ans :**

1. Place two reference shapes : one for the tray, one for the basket.
2. Rotate the first link and second link to align the end-effector over the tray.
3. Then pivot the joints to check if it also aligns over the basket.
4. Adjust link lengths if unreachable.

- 122.** A simple linear press must compress items straight down. Which joint arrangement is best, and how can you show pressing motion in Tinkercad?

**Ans :**

1. A single prismatic joint oriented vertically is best for up-down compression.
2. In Tinkercad, create a vertical rail with a block representing the press plate. Slide it

downward to simulate compression.

3. Confirm there's enough stroke length to compress items fully.

**123.** In a design with limited workspace, your RR arm might risk hitting a surrounding wall. How would you use Tinkercad to address this?

**Ans :**

1. Model the wall in Tinkercad as a static block.
2. Rotate the arm near its boundary angles to see if it intersects the wall.
3. If collisions occur, shorten the second link or impose rotational limits on the joints to avoid contact.

**124.** A robotic display for a science fair must show different basic joint types. You decide to showcase one revolute joint and one prismatic joint. How can Tinkercad help you illustrate both for demonstration?

**Ans :**

1. In Tinkercad, build a hinged arm segment (revolute) and a sliding segment (prismatic).
2. Label them clearly and rotate/slide each to show how rotational vs. linear motion differs.
3. This offers a visual, interactive demonstration for visitors to understand distinct joint concepts.

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# CHAPTER 5

## INTEGRATING ROBOTS AS A SYSTEM

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### SUMMARY

#### 1. SIMPLE ROBOTIC SYSTEMS

A simple robotic system usually includes a basic mechanical structure (e.g., arms, wheels), actuators (motors), a controller (microcontroller or single-board computer), and sensors.

The goal is to perform tasks autonomously or semi-autonomously, such as moving objects, navigating, or executing programmed instructions.

#### 2. PROGRESSION FROM RR MECHANISM TO WHEELED ROBOT

1. RR Mechanism : A planar 2-link robotic arm with two Revolute (R) joints. Students often design and animate this in Tinkercad to learn the basics of kinematics and movement.
2. Wheeled Mobile Robot : Next step involves integrating wheels, a chassis, motors, and steering mechanisms to create a mobile platform.

#### 3. SINGLE BOARD COMPUTERS (SBCS)

Examples : Raspberry Pi, Arduino (microcontroller board, though sometimes categorized similarly), or other SBCs.

##### Functions :

1. Run code that processes sensor data.
2. Send signals to motors or other actuators.
3. Communicate with external devices (PC, phone, Wi-Fi, etc.).

#### 4. TINKERCAD FOR BUILDING SIMPLE ROBOTIC SYSTEMS

##### 4.1 Tinkercad Overview

1. Mechanical Design : Create 3D models of parts like arms, brackets, or chassis.
2. Tinkercad Circuits : Simulate electronic circuits, including breadboards, microcontrollers, and sensors.

3. Benefits : Quick, browser-based, user-friendly environment to visualize both mechanical and basic electronic designs.

##### 4.2 Designing an RR Mechanism in Tinkercad

1. Components : Two links, two revolute joints, base mount.
2. Process : Create cylinders or rectangular rods, align pivot points, group shapes to form each link.
3. Motion Visualization : Manually rotate each revolute joint to check range of motion.

##### 4.3 Designing a Four-Wheeled Mobile Robot in Tinkercad

1. Chassis : A base plate or box-like structure for holding components.
2. Wheels and Axles : Attach one or two DC motors per axle for drive. Alternatively, add a castor wheel for steering or use differential drive.
3. Mounting and Sensors : Position placeholders for sensors (e.g., ultrasonic) and a slot for a single-board computer or microcontroller.

##### 4.4 Coding and Control with Single Board Computers

1. Basics of Microcontroller Coding
  - (i) Languages : C/C++ (Arduino), Python (Raspberry Pi).
  - (ii) IO Control : Digital and analog pins read sensor values and control motors.
  - (iii) Logic : If-else conditions, loops for continuous operation, functions for modular code.
2. Typical Workflow
  - (i) Design : Plan mechanical parts (e.g., wheels, links) in Tinkercad or other CAD tools.
  - (ii) Assemble Hardware : Build the physical chassis or RR arm.
  - (iii) Coding : Write software to read sensors and drive motors.
  - (iv) Testing & Iteration : Verify motion, adjust code, refine hardware as needed.

3. Moving from RR Mechanism to Mobile Robot
  - (i) RR Mechanism : Stationary, focuses on arm movement.
  - (ii) Mobile Robot : Adds locomotion, requiring motor control, potential steering or differential drive logic, and sensor-based navigation.

#### 4.5 Practical Considerations

1. Power Supplies
  - (i) Must match motor and SBC requirements (battery packs, regulated voltages).
  - (ii) Enough current capacity to power motors under load.
2. Motor Drivers Separate driver modules often required (e.g., L298N, motor shields) so the SBC can switch and regulate motor power.
3. Sensor Integration
  - (i) For wheeled robots : distance sensors (ultrasonic, IR) to avoid obstacles.
  - (ii) For arms : encoders or potentiometers to track joint angles.

#### 4.6 Safety and Handling

Robots should have stable bases, secure wiring, and protective circuits to avoid short-circuits or mechanical failures.

### MULTIPLE CHOICE QUESTION

1. Which of the following best describes an RR mechanism in robotics?
  - (a) A 2-link arm with two prismatic joints
  - (b) A 3-wheel mobile platform
  - (c) A planar arm with two revolute joints
  - (d) A robotic gripper with no hinges

Ans :

MAIN 2025

(c) A planar arm with two revolute joints  
RR stands for Revolute-Revolute. This setup is a 2-link manipulator, each link joined by a hinge allowing rotation in a plane. Prismatic joints would provide linear motion, and three-wheel platforms or grippers fall outside the RR classification.

2. In a four-wheeled mobile robot, the mechanical subsystem typically includes \_\_\_\_\_.
  - (a) Sensors only
  - (b) Wheels, chassis, and motor assemblies
  - (c) Internet connectivity modules

- (d) A single manipulator arm

Ans :

SQP 2013

(b) Wheels, chassis, and motor assemblies  
A four-wheeled robot's primary mechanical block consists of the frame or chassis, wheel assemblies, and motors (or servo-based steering). While sensors or connectivity modules are part of the overall system, the mechanical subsystem specifically refers to structural and moving parts like wheels and axles.

3. A single-board computer (SBC) like Raspberry Pi is generally used for \_\_\_\_\_.
  - (a) Simple mechanical linkages
  - (b) High-level control and programming
  - (c) Manual control via gears
  - (d) Only powering motors directly

Ans :

COMP 2006

(b) High-level control and programming  
SBCs like the Raspberry Pi handle more advanced computing tasks, such as running Python code, processing sensor data, or networking. They're not merely mechanical devices and are typically not used to directly power motors (that requires a motor driver). They excel at high-level logic and control.

4. In Tinkercad Circuits, which of the following can be simulated?
  - (a) Advanced finite element analysis
  - (b) Basic microcontroller code and breadboard connections
  - (c) Full mechanical stress tests on gears
  - (d) Real-time torque measurements

Ans :

MAIN 2009

(b) Basic microcontroller code and breadboard connections  
Tinkercad Circuits allows users to assemble virtual breadboards, connect Arduino boards, and run simple code. It supports basic electronics and logic tests but does not perform mechanical stress or torque analysis. High-level mechanical simulations require specialized CAE software.

5. A "chassis" in a wheeled robot is \_\_\_\_\_.
  - (a) The software environment
  - (b) A voltage regulator
  - (c) The base frame carrying all components
  - (d) A specialized sensor for distance measurement

Ans :

MAIN 2021

(c) The base frame carrying all components

The chassis is the foundational structure on which motors, wheels, batteries, sensors, and controllers are mounted. It ensures stability and houses all parts securely. It is not a sensor, software tool, or regulator but the physical body of the robot.

6. Which statement is true about moving from a stationary RR arm to a four-wheeled robot?
- No additional actuators are needed
  - The wheeled robot requires locomotion control for motors
  - Both systems are controlled identically
  - A wheeled robot cannot carry a microcontroller

Ans :

SQP 2016

(b) The wheeled robot requires locomotion control for motors

A stationary RR arm focuses on joint movement only. A wheeled robot adds motor-driven wheels and the need for driving/steering logic. While microcontrollers can control both, the complexity of locomotive control, power distribution, and sensor feedback for navigation is new compared to an RR arm's stationary setup.

7. A typical workflow for building a mobile robot includes which step first?
- Write advanced AI code
  - Physically assemble everything with no plan
  - Design or model the mechanical chassis and wheel arrangement
  - Generate a complicated neural network

Ans :

COMP 2012

(c) Design or model the mechanical chassis and wheel arrangement

Before coding advanced AI or finalizing assembly, designers typically plan out the mechanical layout—how many wheels, chassis dimensions, motor positioning. This ensures the foundation is robust for subsequent steps like sensor integration and coding. A structured workflow starts with design or modeling, then moves to physical building.

8. If you want to test basic electronic wiring for a wheeled robot's motors in Tinkercad, you might use \_\_\_\_\_.
- Tinkercad Circuits with Arduino simulations
  - Fusion 360 for mechanical stress analysis
  - A text editor with no circuit features
  - Direct hardware wiring only

Ans :

MAIN 2014

(a) Tinkercad Circuits with Arduino simulations

Tinkercad Circuits has a virtual Arduino environment where users can wire up motors (with certain limitations), add driver modules, and write code to simulate simple movement logic. Fusion 360 is more mechanical/CAE-focused, while a plain text editor won't simulate circuits. Hardware wiring is real-life, not Tinkercad-based.

9. Which of the following is essential for coding a single-board computer to drive motors?
- A motor driver or H-bridge
  - A camera sensor only
  - A mechanical push button for each motor
  - No additional components required

Ans :

SQP 2010

(a) A motor driver or H-bridge

SBCs or microcontrollers typically cannot handle the current demands of DC motors directly. A motor driver (like an H-bridge) is necessary to supply sufficient power and manage direction/speed. Without it, you risk damaging the controller or failing to control the motors adequately.

10. In Tinkercad 3D design, how might you prototype a four-wheeled mobile chassis?
- By coding Python scripts for each wheel
  - By creating a rectangular base and attaching cylindrical shapes as wheels
  - By doing high-level inverse kinematics
  - By analyzing real-time friction forces on each wheel

Ans :

MAIN 2023

(b) By creating a rectangular base and attaching cylindrical shapes as wheels

Tinkercad's 3D workspace lets you create a box or rectangle for the chassis, then add cylinders or half-spheres as wheels. You can visually align them to represent a basic four-wheeled layout. Advanced friction or kinematics are beyond Tinkercad's scope, but geometry and positioning are straightforward.

11. Why might one choose an RR mechanism for a simple classroom robotic arm project?
- It is too complex for beginners
  - It offers no control over motion
  - It provides easy-to-understand rotational joints suitable for 2D tasks
  - It's the same as a six-axis industrial arm

Ans :

SQP 2015

(c) It provides easy-to-understand rotational joints suitable for 2D tasks

An RR arm is the simplest two-joint rotational design. It clearly demonstrates basic concepts of rotation and coordinate geometry in a plane, perfect for students learning fundamental robotics. A six-axis arm is far more complex, and prismatic joints would be a different motion type.

- 12.** When coding a wheeled robot to move forward, the microcontroller typically \_\_\_\_\_.  
 (a) Sends high signals to drive both left and right motors forward  
 (b) Turns off all motor outputs  
 (c) Checks only for prismatic joints  
 (d) Always rotates the arm's joints

**Ans :**

COMP 2018

(a) Sends high signals to drive both left and right motors forward

For differential drive or typical two-motor setups, moving forward means powering both motors in the same direction. The microcontroller outputs digital or PWM signals to the motor driver, causing both wheels to rotate forward. Prismatic joints or robotic arms might not be involved in basic locomotion instructions.

- 13.** Which describes a single-board computer's role in a four-wheeled robot?  
 (a) Solely mechanical structural support  
 (b) It houses the wheels and motors physically  
 (c) A "brain" that runs the software to interpret sensors and control motors  
 (d) It is not used in robotics at all

**Ans :**

MAIN 2007

(c) A "brain" that runs the software to interpret sensors and control motors

Single-board computers, like Raspberry Pi or Arduino, act as a controlling "brain." They execute code that reads sensor inputs (e.g., distance sensors) and decides motor outputs for navigation or obstacle avoidance. Mechanical tasks (wheels, chassis) are separate from the SBC's role of logic execution and control.

- 14.** In Tinkercad Circuits, if you connect a DC motor directly to an Arduino pin, what might happen?  
 (a) Perfect motor control at any load  
 (b) Possible damage to the Arduino pin due to current overload  
 (c) Full advanced motion control with built-in H-bridge  
 (d) Automatic sensor calibration

**Ans :**

SQP 2008

(b) Possible damage to the Arduino pin due to current overload

Arduino pins typically output a limited current (about 20–40 mA max). A DC motor usually requires significantly more, especially under load. Driving the motor directly risks blowing the pin or resetting the board. A separate driver module or transistor is essential for safe motor control.

- 15.** Which design step is crucial before physically building a four-wheeled robot?  
 (a) Randomly selecting motor voltages  
 (b) Testing mechanical layout and wheel placement in a CAD tool  
 (c) Ignoring center of gravity  
 (d) Eliminating sensor use

**Ans :**

COMP 2024

(b) Testing mechanical layout and wheel placement in a CAD tool

Visualizing the layout (in Tinkercad or similar) ensures wheel spacing, motor alignment, and enough room for electronics. This planning step helps avoid balancing issues or motor interference once assembled. Randomly choosing components without design checks can lead to mechanical instability or hardware conflicts.

- 16.** An RR arm in Tinkercad is rotated to verify \_\_\_\_\_.  
 (a) The code compiles for all microcontrollers  
 (b) 3D collisions and range of motion for each joint  
 (c) Real-time motor torque  
 (d) Cooling fan usage

**Ans :**

MAIN 2019

(b) 3D collisions and range of motion for each joint

Tinkercad's 3D environment lets you manually rotate each link around its pivot, spotting potential collisions and checking that the arm reaches the target positions. This helps confirm that the mechanical design is feasible. It does not directly measure torque or require microcontroller code in that environment.

- 17.** When controlling a four-wheeled robot with a single-board computer, you must \_\_\_\_\_.  
 (a) Directly power the motors from GPIO pins  
 (b) Use multiple prismatic joints in the SBC  
 (c) Ensure motors have separate drivers and the SBC sends logic-level signals  
 (d) Rely solely on a mechanical gear system, no electronics

Ans :

SQP 2011

(c) Ensure motors have separate drivers and the SBC sends logic-level signals

SBC GPIO pins provide low-power logic signals that direct the motor driver. The driver or H-bridge then switches higher currents needed by the motors. Directly powering motors from GPIO pins is unsafe, and purely mechanical gearing lacks the electronic intelligence for typical robotic behaviors.

18. Which of these is a typical sensor to add to a wheeled mobile robot for obstacle detection?

- (a) A revolute hinge
- (b) An ultrasonic distance sensor
- (c) A large gearbox
- (d) A prismatic link

Ans :

COMP 2017

- (b) An ultrasonic distance sensor

Ultrasonic distance sensors are commonly used in mobile robots to measure distances to objects and avoid collisions. Revolute hinges, gearboxes, and prismatic links are mechanical components. A prismatic link alone doesn't detect obstacles; you need an actual sensor like ultrasonic or IR.

19. What is the primary function of a motor driver (e.g., L298N) when building a simple robot?

- (a) It stores compiled code
- (b) It converts mechanical energy into electricity
- (c) It provides power switching and direction control for motors
- (d) It measures distances to obstacles

Ans :

MAIN 2022

- (c) It provides power switching and direction control for motors

A motor driver takes control signals from a microcontroller or SBC and switches higher current to motors, controlling their direction and speed. It does not store code or measure distance; it is an electronic power stage enabling safe, bidirectional motor operation.

20. In a differential drive four-wheeled robot, forward motion usually occurs by \_\_\_\_.

- (a) Spinning the left motors forward and the right motors in reverse
- (b) Ignoring wheel rotation entirely
- (c) Running both left and right motors forward at similar speeds
- (d) Removing the wheels from the chassis

Ans :

SQP 2025

- (c) Running both left and right motors forward at similar speeds

Differential drive robots typically have left and right motor sets. Driving both sides in the same forward direction and speed propels the robot straight. Turning is achieved by varying the relative speeds or directions of each side. Reversing one side or mismatching speeds causes pivots or arcs.

21. A single board computer (SBC) is more advanced than a simple microcontroller because \_\_\_\_.

- (a) It lacks any input-output pins
- (b) It can run a full operating system and handle complex tasks like vision processing
- (c) It automatically drives motors without code
- (d) It's purely mechanical

Ans :

COMP 2021

- (b) It can run a full operating system and handle complex tasks like vision processing  
SBCs (e.g., Raspberry Pi) can run Linux-based OS, handle multitasking, and even process complex sensor data (like camera streams). This sets them apart from basic microcontrollers (like Arduino), which have no OS and more limited computing power. However, both can control digital IO with proper coding.

22. Which of the following is least likely necessary for building a simple four-wheeled mobile robot?

- (a) A chassis
- (b) Four wheels
- (c) Potentiometer for every wheel rotation angle
- (d) A motor driver

Ans :

MAIN 2023

- (c) Potentiometer for every wheel rotation angle  
While certain applications use encoders or sensors to track wheel rotation precisely, a basic four-wheeled robot often runs motors open-loop or uses simpler encoders. Potentiometers for every wheel angle are unusual because wheels typically complete continuous rotations. The other components (chassis, wheels, motor driver) are fundamental.

23. If an RR mechanism is converted into a mobile platform in Tinkercad, what primary design change occurs?

- (a) Joints become prismatic
- (b) Revolute joints are replaced by wheels on axles

- (c) The arm remains stationary with no modifications
- (d) More revolute joints are added for advanced movement

Ans : SQP 2024

(b) Revolute joints are replaced by wheels on axles. Moving from a stationary RR arm to a mobile robot fundamentally shifts the design from jointed links to wheel assemblies and a chassis. The “revolute” concept for arm joints is replaced by rotational wheel axles enabling linear or directional movement across the floor.

24. Which is a valid reason to simulate your design in Tinkercad before final assembly?
- (a) Tinkercad automatically solves advanced AI algorithms
  - (b) It ensures the mechanical layout is feasible and helps detect geometry issues
  - (c) No need for a real prototype after Tinkercad
  - (d) It calculates battery consumption instantly

Ans : COMP 2013

(b) It ensures the mechanical layout is feasible and helps detect geometry issues. Tinkercad’s main advantage is quick 3D visualization, letting you spot alignment mistakes or dimension conflicts before fabricating parts. It doesn’t perform advanced AI or battery analysis automatically, but it does offer an accessible environment to refine mechanical designs early on.

25. When coding a single-board computer for a mobile robot, a typical programming structure is \_\_\_\_\_.
- (a) No loops, just static code
  - (b) A main loop polling sensors and setting motor outputs continuously
  - (c) Entirely manual control with no code logic
  - (d) Only advanced 3D modeling commands

Ans : MAIN 2016

(b) A main loop polling sensors and setting motor outputs continuously. Robots usually run a loop repeatedly reading sensor inputs, processing logic (navigation, obstacle avoidance), and updating motor speeds. This main loop approach ensures real-time responses to changing conditions. Static code or manual control alone is insufficient for autonomous or semi-autonomous movement.

26. A four-wheeled robot typically uses differential drive or steering by \_\_\_\_\_.
- (a) Having no motors at all
  - (b) Splitting left and right wheel outputs for turning
  - (c) Using only prismatic slides on each wheel
  - (d) Oscillating the wheels in place

Ans : SQP 2015

(b) Splitting left and right wheel outputs for turning. In differential drive setups, the left and right wheels each have an independent motor. Turning results from varying speeds or directions : for example, the left wheels might run faster/slower than the right to pivot. This approach is simpler than complex steering linkages on each wheel.

27. Which component is most relevant for sensing how far a wheel has rotated?
- (a) Photointerrupter wheel encoder
  - (b) H-bridge driver
  - (c) Relay switch
  - (d) RR joint pivot

Ans : COMP 2019

(a) Photointerrupter wheel encoder. An encoder disk with holes (photointerrupter) or a magnetic encoder senses wheel rotation increments. The microcontroller or SBC counts pulses to determine how far the wheel has turned. H-bridges drive motors, relay switches are for on/off high-voltage circuits, and RR pivot is unrelated to wheel rotation measurement.

28. When building a small robot in Tinkercad and controlling it with an Arduino, the code to move forward might \_\_\_\_\_.
- (a) Delay all motor pins forever
  - (b) Set the motor driver pins HIGH for both left and right motors
  - (c) Only move the left motor
  - (d) Turn everything off

Ans : MAIN 2006

(b) Set the motor driver pins HIGH for both left and right motors. Driving a differential drive robot forward typically means sending a HIGH or PWM signal to both motor driver inputs so both motors spin forward. If only one motor turns, the robot pivots or spins. Delaying pins or turning them off will not move the robot.

- 29.** One advantage of using a single-board computer over a basic microcontroller is \_\_\_\_.

(a) The SBC can host an operating system and run complex tasks like image processing  
 (b) SBCs have no need for external power  
 (c) SBCs reduce mechanical complexity  
 (d) Microcontrollers are always more expensive

**Ans :**

SQP 2012

(a) The SBC can host an operating system and run complex tasks like image processing  
 SBCs (e.g., Raspberry Pi) run full operating systems, providing higher computational capacity (e.g., for camera-based navigation, network connectivity). Microcontrollers like Arduino are simpler, with no OS. This difference allows SBCs to tackle advanced tasks at the cost of higher power consumption and complexity.

- 30.** A “simple robotic system” typically includes \_\_\_\_.

(a) Only a metal frame with no actuators  
 (b) Mechanical components, motors/actuators, controller, and basic sensors  
 (c) Six advanced degrees of freedom for industrial tasks  
 (d) Unlimited battery life

**Ans :**

COMP 2018

(b) Mechanical components, motors/actuators, controller, and basic sensors  
 Even a basic robot has structural parts (chassis or arm), actuators (motors), a controlling device (microcontroller or SBC), and often at least one sensor for feedback. Industrial-scale DOFs or infinite battery are beyond “simple” definitions.

- 31.** A research team is designing a wheeled robot to navigate narrow corridors using precise turning. Which mechanism is primarily used for steering in such robots?

(a) Fixed axle  
 (b) Differential drive  
 (c) RR mechanism  
 (d) Articulated arms

**Ans :**

MAIN 2011

(b) Differential drive  
 Differential drive is a common method in wheeled robots where independent motor control of each wheel enables smooth turning and navigation. By varying wheel speeds, the robot steers accurately, making it ideal for navigating narrow corridors. This approach offers flexibility, precise control,

and improved maneuverability in confined dynamic environments effectively.

- 32.** A robotics team is integrating sensors on their mobile robot to monitor ambient light variations for adaptive behavior.

Which sensor is best suited for detecting changes in light intensity?

(a) Ultrasonic sensor  
 (b) Photoresistor (LDR)  
 (c) Temperature sensor  
 (d) Gyroscope

**Ans :**

SQP 2009

(b) Photoresistor (LDR)  
 Photoresistors, or LDRs, are analog sensors that vary resistance with light intensity changes. They are well-suited for detecting ambient light variations in robotics. Using a photoresistor enables the robot to adjust its behavior based on lighting conditions, ensuring appropriate responses in environments with dynamic illumination levels consistently for improved performance.

- 33.** A college project requires a robot to move forward until an obstacle is detected, then stop immediately.

Which programming logic is most essential in the microcontroller code?

(a) While loop  
 (b) If-else conditions  
 (c) For loop  
 (d) Switch-case

**Ans :**

COMP 2014

(b) If-else conditions  
 If-else conditions are essential for decision-making in robotics. They allow the microcontroller to evaluate sensor inputs and execute appropriate actions, such as stopping when an obstacle is detected. This logical structure ensures the robot responds correctly to dynamic environments, facilitating autonomous behavior and safe operation during real-time navigation reliably and effectively.

- 34.** A robotics lab is selecting a battery pack for their mobile robot that must power both motors and the SBC.

What is the most crucial consideration when choosing a battery?

(a) Aesthetic design  
 (b) Current capacity  
 (c) Battery color  
 (d) Material density

**Ans :**

MAIN 2007

(b) Current capacity

Current capacity is essential for powering motors and single-board computers. A battery must deliver adequate current under load to prevent performance issues and maintain stable operation during dynamic tasks. Sufficient current ensures prolonged activity and avoids power shortages, thereby preventing system failures and unpredictable robot behavior during intensive operations effectively.

- 35.** A student team uses Tinkercad to design a robotic chassis and simulate its assembly to verify proper part fit.

What key benefit does CAD-based visualization provide?

- (a) Increases hardware cost
- (b) Detects design errors early
- (c) Eliminates sensor requirements
- (d) Enhances software complexity

**Ans :**

SQP 2017

(b) Detects design errors early

CAD-based visualization detects design errors early by enabling precise measurement and simulation of robotic components. It ensures correct dimensions and alignment, reducing costly fabrication mistakes. Early detection accelerates refinement, saves time, and minimizes waste. This process ultimately improves the reliability and performance of the final robotic assembly very effectively.

- 36.** A hobbyist builds a simple robotic system with an Arduino controlling small motors and LEDs.

What is the primary function of a motor driver in such systems?

- (a) Provide decorative lighting
- (b) Regulate and switch motor power
- (c) Control sensor feedback
- (d) Simulate robot movement

**Ans :**

COMP 2010

(b) Regulate and switch motor power

A motor driver regulates and switches power to motors, ensuring safe and controlled operation. It allows the microcontroller to send low-power signals while handling high-power requirements of the motors. This component protects the circuit, prevents voltage spikes, and facilitates efficient motor control in simple robotic systems, ensuring reliable performance effectively.

- 37.** A team is developing a mobile robot that uses continuous sensor feedback for obstacle avoidance. Which sensor best provides non-contact distance measurement?

- (a) Potentiometer
- (b) Ultrasonic sensor
- (c) Tactile sensor
- (d) Encoder

**Ans :**

MAIN 2008

(b) Ultrasonic sensor

Ultrasonic sensors measure distances using sound waves without physical contact, making them ideal for autonomous navigation. They provide real-time feedback on object proximity, allowing the robot to avoid obstacles. This sensor type is widely used in robotics for its accuracy, cost-effectiveness, and reliability in various environmental conditions during operation effectively.

- 38.** A startup is iterating on a wheeled robot design, integrating sensors and refining code for better obstacle avoidance.

What is the typical workflow process for developing such a robotic system?

- (a) Code first, then design hardware
- (b) Assemble hardware, then start coding
- (c) Design, assemble hardware, code, test and iterate
- (d) Only simulate without testing

**Ans :**

SQP 2022

(c) Design, assemble hardware, code, test and iterate

The typical workflow in robotic development begins with designing mechanical parts and circuits, followed by hardware assembly. Next, coding integrates sensor and actuator functions. Subsequent testing and iterative refinements ensure functionality and performance. This systematic approach minimizes errors, optimizes design, and accelerates the development of reliable robotic systems efficiently.

- 39.** A robotics lab emphasizes safety when building prototypes. A technician reviews wiring and protective circuits to prevent failures.

What safety measure is most crucial for ensuring a robot's safe operation?

- (a) Unsecured wiring
- (b) Stable base and protective circuits
- (c) Excessive power supply
- (d) Omitted safety circuits

**Ans :**

COMP 2025

(b) Stable base and protective circuits

A stable base and protective circuits are critical safety measures in robotics. They ensure that the robot remains secure during operation and prevent electrical faults or short circuits. Proper wiring and protective components mitigate risks of mechanical failures and accidents, thereby ensuring safe, reliable performance in environments during operation effectively.

40. A startup is transitioning from manual control to an automated system using sensor feedback for dynamic adjustments.

What is the primary advantage of automatic control systems over manual systems?

- (a) Reduced flexibility
- (b) Enhanced real-time feedback and adjustment
- (c) Increased human intervention
- (d) Limited sensor integration

Ans :

MAIN 2021

(b) Enhanced real-time feedback and adjustment  
Automatic control systems utilize continuous sensor feedback to adjust robotic movements in real time. This dynamic adjustment ensures precision, enhances reliability, and minimizes human error. By comparing actual performance to desired outcomes, these systems provide superior adaptability and efficiency, making them preferable over manual systems in complex, real-world applications effectively.

41. Which statement about building a simple robotics system is correct?

- (a) It never includes motors or sensors
- (b) It solely relies on mechanical gears with no control logic
- (c) It typically includes mechanical parts, actuators, and a controller with basic code
- (d) It never requires any form of power supply

Ans :

SQP 2023

(c) It typically includes mechanical parts, actuators, and a controller with basic code  
Even a basic system needs mechanical parts, motors or actuators, and a controller that runs code to orchestrate behavior. Power supply is also essential, and sensors are often present. Purely gear-based or power-free setups would not constitute a functioning robot, which requires some electronics and logic.

42. Which statement correctly describes an RR mechanism's movement?

- (a) Both joints slide linearly
- (b) One joint is revolute, the other prismatic
- (c) Each joint rotates around its own pivot axis
- (d) Both joints are ball-and-socket

Ans :

COMP 2024

(c) Each joint rotates around its own pivot axis  
The RR mechanism is named for two revolute joints, each rotating. No prismatic or ball-and-socket joints exist in a standard RR configuration. Revolute means hinge-like motion about a single axis, so statement C accurately captures its fundamental movement style.

Which is the correct statement about single-board computers in robotics?

- (a) They cannot be programmed at all
- (b) They often run full OSs and handle higher-level tasks like vision
- (c) They replace wheels in a mobile robot
- (d) They only serve as mechanical frames

Ans :

MAIN 2013

(b) They often run full OSs and handle higher-level tasks like vision  
SBCs (e.g., Raspberry Pi) often run Linux, performing sophisticated tasks such as image recognition, AI, or networking. They do not act as mechanical components like wheels or frames. They are highly programmable, allowing advanced control and interface with multiple sensors and actuators.

44. Which statement about Tinkercad's usage in robotics projects is correct?

- (a) It performs detailed stress analysis of each robotic part
- (b) It allows simple 3D modeling and circuit simulation for basic concepts
- (c) It automatically generates final manufacturing files for complex CNC steps
- (d) It calculates real-time battery usage

Ans :

SQP 2016

(b) It allows simple 3D modeling and circuit simulation for basic concepts  
Tinkercad is well-suited for conceptual 3D models (e.g., chassis, links) and simulating basic circuits with an Arduino. It is not intended for advanced mechanical or power consumption analysis. Designers typically move to specialized software for stress or professional manufacturing details.

- 45.** Which statement is correct regarding motor drivers in a wheeled robot?
- (a) They are unnecessary if you have a single-board computer
  - (b) They only apply to stepper motors, never DC motors
  - (c) They remove the need for any code logic
  - (d) They prevent high current from damaging the controller by switching power to the motors

Ans :

COMP 2015

(d) They prevent high current from damaging the controller by switching power to the motors  
A motor driver (e.g., L298N) switches higher currents required by the motors, protecting the SBC or microcontroller's low-current output pins. Code logic still controls the driver. They are relevant for DC motors (and can also apply to steppers, but with specialized drivers). Hence, option (d) is correct.

- 46.** Which statement about a four-wheeled robot is correct?
- (a) It relies on at least one motor driver and a power supply to run wheels
  - (b) It cannot move unless it has prismatic joints
  - (c) It never uses any sensors
  - (d) It is identical to an RR arm in design

Ans :

MAIN 2019

(a) It relies on at least one motor driver and a power supply to run wheels  
Four wheels driven by DC motors require a driver or H-bridge to manage current and direction, plus a power source. Prismatic joints are not mandatory for wheels, sensors are commonly added, and an RR arm is a separate concept focusing on two rotational joints.

- 47.** Identify the correct statement about coding a single-board computer for a mobile robot.
- (a) No coding is needed if the motors are attached
  - (b) The microcontroller code never uses loops
  - (c) A main loop reads sensors and updates motor commands for navigation
  - (d) The battery alone determines robot speed

Ans :

SQP 2006

(c) A main loop reads sensors and updates motor commands for navigation  
Robots generally run continuous loops polling sensors (distance, IMU, etc.) and computing motor outputs (speed, direction). Without code, the robot cannot respond to environment changes.

Loops are fundamental, and while battery voltage influences speed, it is not the only controlling factor.

NODIA

- 48.** Which statement correctly compares an RR mechanism and a wheeled robot?
- (a) Both are stationary devices
  - (b) An RR mechanism manipulates in place, while a wheeled robot navigates environments
  - (c) Both rely on prismatic joints
  - (d) A wheeled robot always has six or more wheels

Ans :

COMP 2012

(b) An RR mechanism manipulates in place, while a wheeled robot navigates environments  
An RR arm typically stays in one spot, rotating two joints to move an end-effector. A wheeled mobile robot drives around, scanning or interacting with the environment. Prismatic joints are irrelevant in an RR system, and wheel counts vary, not necessarily six or more.

- 49.** Which is the correct statement about Tinkercad Circuits for a beginner project?
- (a) It replaces all real hardware testing
  - (b) It is worthless without advanced physics modules
  - (c) It can simulate basic Arduino code, breadboard wiring, and LED/motor setups
  - (d) It supports only mechanical stress analysis

Ans :

MAIN 2007

(c) It can simulate basic Arduino code, breadboard wiring, and LED/motor setups  
Tinkercad Circuits is an educational tool that allows users to wire up virtual Arduino microcontrollers, add components on a breadboard, and run simple code for blinking LEDs or driving motors. It does not replace final hardware testing, nor does it provide advanced mechanical/physics analysis.

- 50.** Which statement about differential drive is correct?
- (a) It requires linear slide joints in each wheel
  - (b) Steering is achieved by varying the relative speed/direction of the left and right wheels
  - (c) The robot can only move in circles with no forward motion
  - (d) It depends entirely on prismatic axes

Ans :

SQP 2017

(b) Steering is achieved by varying the relative speed/direction of the left and right wheels

A differential drive robot steers by controlling two independent motorized wheel sets. Changing speed or reversing one side modifies the turning radius. Linear slides or prismatic joints are not involved in typical wheel-based setups, and the robot can certainly move straight by driving both wheels equally.

## ASSERTION AND REASON

- 51. Assertion (A) :** An RR arm is suited for planar pick-and-place tasks.

**Reason (R) :** Each revolute joint provides linear movement along one axis.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(c) Assertion is correct, but Reason is incorrect. The assertion is correct—RR arms excel at planar manipulations. The reason is incorrect because revolute joints offer rotational, not linear, motion. Therefore, while it's true that RR arms are good for planar tasks, the provided reason describing linear movement does not apply to revolute joints.

- 52. Assertion (A) :** A single-board computer can run an operating system that manages multiple tasks.

**Reason (R) :** Basic microcontrollers typically have no operating system and perform one main loop program.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are true, and the second explains the difference : SBCs can run complex OSs handling multitasking, while microcontrollers usually run a single program repeatedly. This

contrast clarifies why SBCs can manage more resource-intensive tasks like image processing.

- 53. Assertion (A) :** Tinkercad is useful for visualizing a four-wheeled robot's basic geometry before building.

**Reason (R) :** Tinkercad provides an advanced physics engine for real-time torque calculations.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(c) Assertion is correct, but Reason is incorrect. The assertion is correct : Tinkercad is helpful for basic geometry and layout. However, the reason is incorrect; Tinkercad does not offer an advanced physics engine for real-time torque analysis. Its primary function is simplified 3D modeling, not robust mechanical simulations.

- 54. Assertion (A) :** Motor drivers are critical in controlling DC motors from SBCs.

**Reason (R) :** SBC GPIO pins typically cannot supply the high current needed by motors.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are true and the reason directly explains the need for a motor driver. SBC pins have limited current capacity, making an external driver essential for powering motors without damaging the board. Thus, the reason properly justifies the assertion.

- 55. Assertion (A) :** A differential drive robot with identical wheel speeds will move straight.

**Reason (R) :** Both wheels rotating forward at equal speed produce balanced linear motion.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. The assertion is correct, and the reason succinctly explains it. In differential drive, symmetrical wheel speed results in straightforward motion. If speeds differ, the robot arcs or pivots. This scenario exemplifies how controlling relative wheel speeds manages linear vs. turning movement.

- 56. Assertion (A) :** An RR arm cannot move unless it is placed on a mobile robot base.

**Reason (R) :** RR arms have rotating joints that allow them to move in place even if they're not on wheels.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because an RR arm can rotate in place on a fixed table or stand. The reason is correct : the rotating joints themselves provide motion, independent of mobility. Hence, the assertion is wrong, but the reason is right.

- 57. Assertion (A) :** A single-board computer can connect to Wi-Fi and run Python-based robot control.

**Reason (R) :** Microcontrollers typically do not have a native OS but can be programmed in C/C++ for simpler tasks.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(b) Both Assertion and Reason are correct, but Reason is not the correct explanation.

Both statements are true. SBCs often have Wi-Fi

capabilities and can run Python on an OS, while microcontrollers usually rely on direct code without an OS. However, the reason does not directly explain why SBCs can do Wi-Fi and Python; it only states a fact about microcontrollers.

- 58. Assertion (A) :** Tinkercad Circuits automatically calculates battery runtime based on motor current draws.

**Reason (R) :** Tinkercad Circuits offers a basic environment for wiring and code simulation, not advanced battery analytics.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect—Tinkercad Circuits does not compute battery runtime. The reason is correct : it's meant for simple circuit simulations and code tests, lacking advanced power consumption or battery analysis features. Therefore, the reason accurately contradicts the assertion.

- 59. Assertion (A) :** A four-wheeled robot might incorporate an RR arm on top.

**Reason (R) :** Mobile manipulation combines a mobile base and a manipulator for increased task variety.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both the assertion and the reason are correct, and the reason explains the concept of "mobile manipulation." Placing an RR arm atop a wheeled base allows the robot to navigate and also manipulate objects within reach, extending its usefulness significantly.

**60. Assertion (A) :** In a simple robotic system, the mechanical design is irrelevant as long as the code is robust.

**Reason (R) :** Mechanical structure and code must align for reliable motion and stability.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because code alone cannot fix a poorly designed mechanical structure. The reason is correct : mechanical design and software are interdependent; stable, functional hardware complements well-written code. Without synergy between them, the robot's performance suffers.

## STATEMENT BASED QUESTIONS

**61.** Consider the following statements about the components of a simple robotic system :

- 1. A simple robotic system usually includes a basic mechanical structure (e.g., arms, wheels), actuators (motors), a controller (microcontroller or single-board computer), and sensors.
  - 2. A simple robotic system can operate effectively without any sensors since sensors are not essential for autonomous or semi-autonomous tasks.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct. The material specifies that a simple robotic system includes mechanical parts, actuators, a controller, and sensors to perform tasks. Sensors are essential for autonomous or semi-autonomous operations, so statement 2 is incorrect.

**62.** Consider the following statements regarding the progression from an RR Mechanism to a Wheeled

Mobile Robot :

- 1. An RR Mechanism is a planar 2-link robotic arm with two revolute joints used to learn the basics of kinematics and movement (often designed in Tinkercad).
  - 2. Transitioning from an RR Mechanism to a wheeled mobile robot involves only adding wheels, without any significant changes to the control or mechanical complexity.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct. The RR Mechanism is a basic robotic arm designed to teach kinematics, while progressing to a mobile robot involves not only adding wheels but also additional control logic (such as motor control, steering, and sensor-based navigation). Therefore, statement 2 is incorrect.

**63.** Consider the following statements about Single Board Computers (SBCs) in robotic systems :

- 1. Examples of SBCs include Raspberry Pi and Arduino, which run code to process sensor data, control motors, and communicate with external devices.
  - 2. An SBC is a large and complex computing system that cannot directly interface with sensors or actuators.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct. SBCs such as Raspberry Pi and Arduino are designed to interface with sensors and actuators, processing data and controlling hardware. Statement 2 is incorrect because SBCs are compact and specifically built for interfacing with hardware components.

**64.** Consider the following statements about Tinkercad's role in building robotic systems :

- 1. Tinkercad provides tools for both mechanical design (creating 3D models of parts) and simulating electronic circuits (including microcontrollers and sensors).

2. Tinkercad is limited solely to mechanical design and does not support electronic circuit simulation.

- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

Ans :

- (a) Only statement 1 is correct.

Tinkercad is a versatile, browser-based tool that supports both 3D mechanical design and electronic circuit simulation. Statement 2 is false because it contradicts Tinkercad's capabilities.

65. Consider the following statements about designing an RR Mechanism in Tinkercad :

1. Designing an RR Mechanism in Tinkercad involves creating components such as cylinders or rods, aligning pivot points, and grouping shapes to form each link.  
 2. Motion visualization in an RR Mechanism design in Tinkercad is fully automated, with no need to manually rotate the joints to verify the range of motion.

- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

Ans :

- (a) Only statement 1 is correct.

The process of designing an RR Mechanism involves manual steps such as aligning pivot points and grouping shapes. The text specifies that motion visualization is achieved by manually rotating each revolute joint, making statement 2 incorrect.

66. Consider the following statements regarding the design of a four-wheeled mobile robot in Tinkercad :

1. Designing a four-wheeled mobile robot typically includes creating a chassis, adding wheels and axles (with DC motors), and providing mounting spots for sensors and a single-board computer.  
 2. When designing a four-wheeled mobile robot in Tinkercad, motor drivers are unnecessary because motors can be directly connected to the single-board computer without additional hardware.

- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.

- (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

Ans :

- (a) Only statement 1 is correct.

Statement 1 accurately describes the design elements of a four-wheeled mobile robot. Statement 2 is incorrect because motor drivers are typically required to safely and effectively control the motors.

67. Consider the following statements about coding and control with Single Board Computers :

1. Microcontroller coding for robotic systems often uses languages such as C/C++ (for Arduino) and Python (for Raspberry Pi), employing if-else conditions, loops, and functions.  
 2. IO control in such coding involves using digital and analog pins to both read sensor data and control actuators like motors.  
 (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

Ans :

- (c) Both statements 1 and 2 are correct.

Both statements accurately reflect the coding practices for microcontrollers in robotic systems. They cover the use of common programming languages and the role of IO control in interfacing with sensors and actuators.

68. Consider the following statements about the typical workflow in developing a robotic system :

1. The workflow involves designing mechanical parts (using tools like Tinkercad), assembling the hardware, coding for sensor reading and motor control, and performing testing with iterative refinements.  
 2. Once the hardware is assembled, the coding phase is a one-time process with no need for further adjustments or iterations.  
 (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

Ans :

- (a) Only statement 1 is correct.

The development process is iterative, involving testing and refinement after initial coding and hardware assembly. Statement 2 is incorrect

because further adjustments are often necessary.

**69.** Consider the following statements regarding the transition from an RR Mechanism to a mobile robot :

1. An RR Mechanism is typically stationary and focuses on arm movement, while a mobile robot incorporates locomotion through motor control and sensor-based navigation.
  2. Both the RR Mechanism and the mobile robot use identical control logic since they perform similar tasks.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

The RR Mechanism is designed for stationary arm movements, whereas a mobile robot adds the complexity of movement and navigation. Statement 2 is false because the control logic for a mobile robot is more complex and different from that of an RR Mechanism.

**70.** Consider the following statements about practical considerations in building robotic systems :

1. Practical considerations include ensuring that power supplies meet the requirements of both motors and single-board computers, and using motor drivers to safely regulate motor power.
  2. Sensor integration is optional in robotic systems since a well-designed mechanical structure is sufficient for safe and effective operation.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

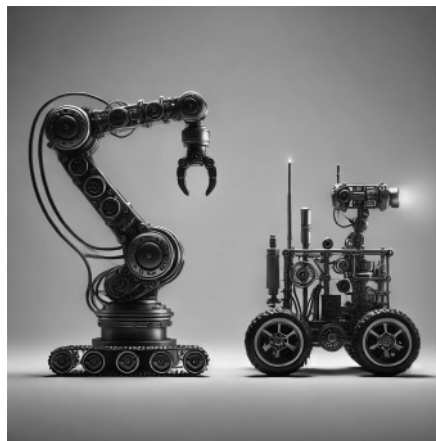
- (a) Only statement 1 is correct.

The material stresses the importance of matching power supplies and using motor drivers, as well as integrating sensors (for obstacle avoidance, position tracking, etc.) for effective operation. Statement 2 is incorrect because sensor integration is critical, not optional.

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## PICTURE BASED QUESTIONS

**71.** Observe the images :



Which statement best describes the difference between the two?

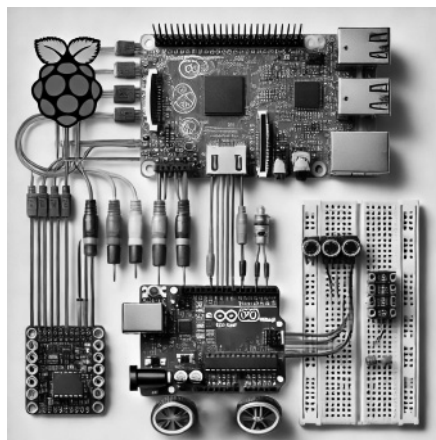
- (a) The robotic arm is mobile, but the wheeled robot is stationary.
- (b) Both systems use wheels for motion.
- (c) The robotic arm focuses on controlled movement of links, while the wheeled robot moves using motors.
- (d) Neither system requires actuators.

**Ans :**

- (c) The robotic arm focuses on controlled movement of links, while the wheeled robot moves using motors.

A robotic arm is a stationary system with actuated joints, whereas a wheeled robot is designed for movement, using motors and sensors for navigation.

**72.** Look at the images :



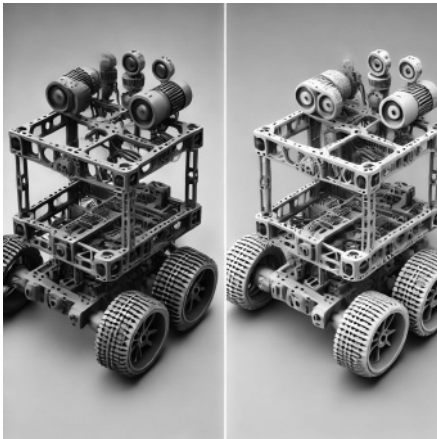
Which of the following is true?

- (a) Raspberry Pi and Arduino function identically.
- (b) Single-board computers like Raspberry Pi process data and control actuators.
- (c) Microcontrollers cannot be used in robotics.
- (d) SBCs only control motors, not sensors.

Ans :

(b) Single-board computers like Raspberry Pi process data and control actuators. SBCs such as Raspberry Pi or Arduino process sensor data, send signals to actuators, and communicate with external systems, enabling robotic control.

73. Consider the images :



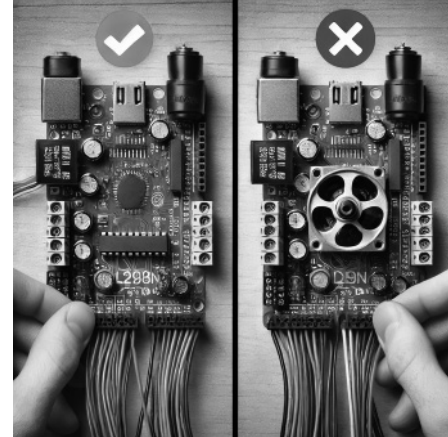
Which statement is correct?

- (a) The first design is ready for motion, while the second lacks essential robotic components.
- (b) Both models function identically.
- (c) Neither requires additional components for functionality.
- (d) The second model is more advanced.

Ans :

(a) The first design is ready for motion, while the second lacks essential robotic components. A wheeled robot needs a proper chassis, motor mounts, and sensor placements, which the first design includes, while the second is just a static frame.

74. Look at the images :



Which setup is correct for controlling motors?

- (a) The first image correctly uses a motor driver, while the second risks damaging the microcontroller.
- (b) The second image is the best way to power motors.
- (c) Both setups function identically.
- (d) Motors do not require additional drivers.

Ans :

(a) The first image correctly uses a motor driver, while the second risks damaging the microcontroller.

Motor drivers (like L298N) regulate voltage and current for motors. Directly connecting a motor to a microcontroller can cause damage due to high power draw.

## TWO MARKS QUESTIONS

75. What is an RR mechanism in robotics?

Ans :

MAIN 2025

It's a 2-link manipulator with two revolute (rotational) joints, allowing planar motion. Each joint pivots, providing two degrees of freedom in a flat plane.

76. Why is a motor driver essential when using a single-board computer to run DC motors?

Ans :

COMP 2010

SBC GPIO pins cannot supply the high current that motors need. The motor driver switches the larger current safely and controls direction/speed based on SBC signals.

- 77.** Name two key components of a four-wheeled mobile robot.

**Ans :** MAIN 2008

Common essentials include a sturdy chassis and DC motors (with wheels) controlled by a motor driver and a microcontroller or SBC.

- 78.** What basic feature does Tinkercad Circuits provide for beginners?

**Ans :** SQP 2022

It simulates Arduino-based circuits, letting users wire motors, LEDs, and sensors on a virtual breadboard and run simple code to test functionality.

- 79.** How does a differential drive robot turn left or right?

**Ans :** MAIN 2024

By running the left and right wheels at different speeds. For instance, faster on the right side and slower on the left yields a turn to the left.

- 80.** Explain one advantage of using a single-board computer like Raspberry Pi for robotics.

**Ans :** SQP 2019

It can handle complex tasks—such as image processing, Wi-Fi networking, or multitasking—thanks to its operating system and higher processing power.

- 81.** Define a “simple robotic system.”

**Ans :** COMP 2011

It typically consists of a basic mechanical structure (chassis or arm), minimal actuators (motors), a controller (microcontroller or SBC), and possibly a sensor—designed to perform straightforward tasks like movement or pick-and-place.

- 82.** Why would you visualize a four-wheel chassis in Tinkercad before physical assembly?

**Ans :** MAIN 2017

To check if all parts fit, if wheel spacing is correct, and if there’s enough room for electronics. Early visualization avoids costly mistakes in cutting or drilling.

- 83.** Mention one reason for adding a sensor to a wheeled robot.

**Ans :** SQP 2022

Sensors allow the robot to detect obstacles or measure its environment, enabling autonomous navigation or safety features like collision avoidance.

- 84.** What does “closed-loop control” mean in the context of motor control?

**Ans :** COMP 2021

It involves using sensor feedback (like encoders) to compare actual speed or position with a setpoint, adjusting motor signals accordingly to reduce error.

- 85.** State one difference between an RR arm and a wheeled robot.

**Ans :** MAIN 2016

An RR arm is stationary, focusing on joint rotation for manipulations, while a wheeled robot moves its entire body across surfaces for navigation.

- 86.** Give one example of a sensor that might be used for obstacle detection on a mobile robot.

**Ans :** SQP 2012

An ultrasonic sensor measuring distance by emitting sound pulses and timing the echo reflection can detect objects to avoid collisions.

- 87.** Why is battery selection important for mobile robots?

**Ans :** COMP 2014

The robot’s motors and controller demand sufficient voltage and current. An undersized battery may cause power drops, while an oversized one adds unnecessary weight.

- 88.** What is the purpose of a chassis in a wheeled robot?

**Ans :** MAIN 2010

The chassis provides the structural foundation to mount wheels, motors, power supplies, controllers, and sensors in a stable manner.

- 89.** How does Tinkercad help students grasp the RR mechanism?

**Ans :** SQP 2023

By letting them model each link and pivot, then rotate the joints to see real-time orientation changes, clarifying how revolute joints produce motion.

- 90.** Mention one coding task required for a four-wheeled robot.

**Ans :** COMP 2015

Writing a loop that reads sensor data (e.g., from an ultrasonic sensor) and adjusts motor speeds to avoid obstacles.

- 91.** What are the basic electronics involved in a DC motor setup for a mobile robot?

**Ans :** MAIN 2018

Typically includes the motor, a motor driver (H-bridge), a power source (battery), and a controller (Arduino, SBC) providing control signals.

- 92.** Why might a robot builder move from Tinkercad to a more advanced CAD tool?

**Ans :** SQP 2007

For detailed mechanical simulations, stress analysis, or complex assemblies that Tinkercad's simpler environment cannot handle fully.

- 93.** Define "differential drive."

**Ans :** COMP 2008

A drive system using two independently powered wheels on either side of a chassis. Speed differences between wheels control turning and direction.

- 94.** Why does an SBC or microcontroller code often have a continuous loop?

**Ans :** MAIN 2025

The robot must react to sensor data and environment changes in real time. A loop structure regularly updates motor outputs and processes inputs.

## THREE MARKS QUESTIONS

- 95.** Explain how an RR arm works in a classroom scenario.

**Ans :** SQP 2013

Two revolute joints enable the arm's two links to rotate, covering a 2D area. Students can attach a small gripper or pointer at the end-effector. Simple code can control the joint angles to perform pick-and-place or trace shapes on a plane.

- 96.** Describe the key functions of a motor driver in a wheeled robot.

**Ans :** COMP 2006

It interprets logic-level signals from the SBC or microcontroller and switches power to motors accordingly. It can reverse polarity for forward/reverse, control speed via PWM, and protect the controller from high current. This isolation is crucial for reliable, safe operation.

- 97.** How does Tinkercad Circuits help beginners learn about microcontroller-based robot control?

**Ans :** MAIN 2009

It allows users to wire up virtual components (motors, LEDs, sensors) and write Arduino code in an online simulator. Beginners see immediate results, like an LED blinking or a motor spinning, without needing physical hardware. This environment fosters iterative learning and testing.

- 98.** Why is designing a stable chassis important for a four-wheeled mobile robot?

**Ans :** SQP 2014

A stable chassis ensures balanced weight distribution, preventing tipping or unpredictable movement. It provides proper mounting for motors and batteries so vibrations and loads don't loosen parts. A well-thought-out chassis also simplifies maintenance and sensor placement.

- 99.** Discuss one challenge of coding an SBC for a mobile robot and a possible solution.

**Ans :** COMP 2010

A challenge is real-time motor control and sensor management, especially if the SBC is multitasking. A solution is to implement efficient scheduling or use a lightweight real-time approach (threads, interrupts) so the robot remains responsive. Offloading lower-level tasks to a microcontroller is also viable.

- 100.** Compare a stationary RR arm to a mobile four-wheeled robot in terms of applications.

**Ans :** MAIN 2025

The RR arm handles localized tasks, like picking objects from a conveyor next to it. A four-wheeled robot can navigate environments (e.g., exploring rooms), but may lack the precision manipulations of the arm unless combined with additional joints or a manipulator.

- 101.** How can a user test a rudimentary ‘move forward’ command in Tinkercad Circuits?

Ans :

SQP 2023

They can place an Arduino, connect a motor driver and two DC motors, and write code setting digital pins HIGH for both motors. Observing the simulation shows motors spinning in the forward direction. While actual friction or load isn’t simulated, the concept is verified.

- 102.** What is one benefit of using a single-board computer with built-in Wi-Fi in a mobile robot project?

Ans :

COMP 2013

Wireless connectivity enables remote monitoring and control. The robot can receive updates, stream sensor data, or even host a small web server, allowing real-time teleoperation or debugging without physical cables attached.

- 103.** Explain how sensor feedback can improve a four-wheeled robot’s navigation.

Ans :

MAIN 2015

Sensors (e.g., ultrasonic, IR) detect obstacles or measure distance. The controller adapts motor speeds to avoid collisions or follow walls. This feedback loop transitions the robot from blindly driving forward to intelligently responding to its surroundings, enhancing safety and autonomy.

- 104.** Why might an RR mechanism be introduced to students before more complex manipulators?

Ans :

SQP 2006

It teaches core kinematic principles—angles, rotational DOF, planar motion—without overwhelming complexity. Students learn how two angles can define position in a plane, forming a strong foundation for adding more joints or advanced constraints later.

- 105.** How does differential drive simplify the mechanical design of a mobile robot?

Ans :

COMP 2018

Each side’s wheels share one motor or motor pair, avoiding the need for steering linkages. Turning is purely electronic, adjusting speed on each side. The simplicity reduces mechanical complexity, but it does require careful speed control to achieve accurate directional changes.

- 106.** Discuss a scenario where Tinkercad’s 3D modeling clarifies potential issues in robot design.

Ans :

MAIN 2009

If a student designs a four-wheel chassis that’s too narrow for certain motors, Tinkercad reveals overlap or insufficient space. Realizing the problem in CAD allows the student to adjust dimensions digitally rather than re-drilling or scrapping materials after a real build fails.

- 107.** What does it mean to integrate an arm onto a wheeled robot, and why might it be beneficial?

Ans :

SQP 2007

Integrating an arm (manipulator) onto a mobile base creates a “mobile manipulator.” It can navigate to a location and then pick up or manipulate objects, expanding capabilities beyond fixed reach. Such systems are used in service robotics, warehousing, or assistive tasks where mobility plus manipulation is needed.

- 108.** How do single-board computers handle sensor data differently from basic microcontrollers?

Ans :

COMP 2010

SBCs can run complex operating systems, multitasking multiple sensor processes simultaneously, or even performing advanced processing (e.g., vision recognition). Microcontrollers typically handle sensor data in a single loop, focusing on real-time tasks but lacking the computational overhead for CPU-intensive processes.

- 109.** Describe one practical use case for an RR mechanism in a simple industrial environment.

Ans :

MAIN 2022

A small assembly station can have an RR arm pick and place components on a rotating table. Its two rotational joints can move parts efficiently across a limited 2D workspace, ideal for repetitive tasks that don’t demand extra degrees of freedom.

- 110.** Why is power management crucial for a wheeled mobile robot?

Ans :

SQP 2021

Motors draw significant current, and the controller’s logic must remain stable. Poor battery choices or voltage regulation lead to brownouts, erratic behavior, or motor stalls. Proper power design ensures reliability, extended run times, and prevents damage to sensitive electronics.

- 111.** What additional complexity does a four-wheel robot face compared to a two-wheel differential drive?

**Ans :** COMP 2024

Four-wheel setups might introduce skid-steering or need a differential or steering mechanism for front wheels. Ensuring all wheels track the same path or pivot smoothly can be more complex than controlling just two powered wheels and a castor.

- 112.** Explain how a developer might use a loop in Arduino code to continuously poll an ultrasonic sensor and set wheel speeds.

**Ans :** MAIN 2016

Within `loop()`, they read the ultrasonic sensor's distance. If it's below a threshold, the code slows or reverses motors. Otherwise, it drives forward at a set speed. This cycle repeats, giving the robot real-time obstacle avoidance.

- 113.** What is the value of merging mechanical models from Tinkercad with actual coding tests in Tinkercad Circuits before building physically?

**Ans :** SQP 2019

You confirm geometric feasibility and basic circuit logic early. This synergy reduces trial-and-error in hardware, saving time and resources. The integrated approach helps novices understand the interplay between mechanical layout and electronic control.

- 114.** Discuss one learning outcome from constructing a simple robotic system with a single-board computer.

**Ans :** COMP 2012

Students gain hands-on experience in mechanical design, electronics integration, and coding. They learn how hardware constraints inform software solutions, bridging theoretical knowledge with practical problem-solving—valuable skills in modern STEM education.

## CASE BASED QUESTION

- 115.** A student builds a small RR arm with Tinkercad and wants to add it atop a simple two-wheel mobile platform. Discuss design considerations.

**Ans :**

1. Chassis Stability : The platform must handle the arm's torque without tipping.
2. Mounting : Securely attach the RR arm's base.
3. Power & Control : Ensure the microcontroller or SBC can drive both the arm servos and the wheels, possibly needing separate power lines.
4. Sensor Integration : Possibly add distance sensors or encoders to maintain stable navigation despite arm movements.

- 116.** You're using Tinkercad Circuits to simulate a four-wheeled robot's motor control. Outline your approach.

**Ans :**

1. Components : Place an Arduino, a dual motor driver (L293D or L298N), and DC motors in the simulator.
2. Wiring : Connect the driver inputs to Arduino digital pins, motors to driver outputs, and power supply lines.
3. Coding : Write a loop controlling forward, reverse, turning (varying motor signals).
4. Verification : Check that signals activate the motors as intended in Tinkercad's simulation, though real load is not modeled.

- 117.** A teacher wants students to learn about controlling motors from an SBC. They aim to code a forward-backward drive. What hardware and software steps are needed?

**Ans :**

Hardware:

1. Components: Raspberry Pi, motor driver (e.g., H-bridge), DC motors, battery, and necessary wiring.
2. Setup: Connect Raspberry Pi GPIO pins to motor driver inputs, attach motor outputs to motors, and share a common ground with the battery.

Software:

1. Script: Write a Python program using a GPIO library (like RPi.GPIO) that sets pins for forward (one HIGH, one LOW) and then reverses them for backward.
2. Testing: Run and verify the behavior on a bench before full deployment.

- 118.** A small forklift design uses a prismatic joint to raise/lower a platform and four wheels for mobility. Describe a Tinkercad mock-up process.

Ans :

1. Prismatic Mechanism : Model rails and a sliding platform for vertical motion.
2. Chassis : Sketch a rectangular base with wheels attached.
3. Integration : Ensure enough space for the platform's vertical travel.
4. Check : Manually slide the forklift's prismatic portion in Tinkercad, verifying clearances with the chassis and wheel assemblies.

- 119.** Students suspect their four-wheeled robot draws too much current from the battery. They want to see if Tinkercad can confirm it. Propose a strategy.

Ans :

1. Expectation Setting : Tinkercad Circuits can estimate motor draw if the library has approximate models, but it can't measure exact real-world current.
2. Approach : They can place generic motors with typical current specs, run the code, and see indicated draw.
3. Conclusion : A real ammeter test is needed physically, but Tinkercad can serve as a rough reference and learning tool.

- 120.** The teacher wants to combine an RR arm with a line-following four-wheel robot. How should the code structure look?

Ans :

1. Main Loop : Repeatedly read line sensor to adjust wheel speeds.
2. Arm Control : Check user commands or an internal routine to move the arm.
3. Integration : Possibly prioritize line-following first, then accept arm commands when safe.
4. Scheduling : Avoid blocking delays; use non-blocking code to keep the robot responsive to both line and arm tasks.

- 121.** A simplified conveyor belt is desired, and the teacher suggests reusing the Tinkercad RR arm design. Evaluate feasibility.

Ans :

1. Mismatch : An RR arm primarily rotates. A conveyor belt uses continuous linear motion.
2. Possible : The arm might place items onto a small belt or vice versa, but the belt itself is a different mechanism.
3. Conclusion : The arm design can't become a belt; it can feed or remove items from the

belt, though.

- 122.** A student tries to make an "inverse kinematics" solver for the RR arm but only has Tinkercad for modeling. Recommend an approach.

Ans :

1. Concept : Tinkercad can show geometry, but it cannot solve IK automatically.
2. Manual Approach : Use known formulas or math in a separate environment (like a Python script) to compute angles for a desired end-point.
3. Testing : Validate those angles by rotating links in Tinkercad to confirm the end-effector's position.

- 123.** In a competition, you need a four-wheeled robot that can make sharp turns in a small arena. What design parameters matter?

Ans :

1. Wheel Spacing : A shorter wheelbase can pivot tighter in differential drive.
2. Wheel Size : Should match the environment's traction needs.
3. Motor Torque : Enough to pivot quickly without stalling.
4. Battery : Sufficient capacity for repeated sharp turns without voltage drop.

- 124.** Your wheeled robot sometimes drifts left even though both motors receive the same PWM signal. Diagnose potential causes.

Ans :

1. Mechanical Variation : One motor or wheel might have more friction, or a slight misalignment in wheel mounting.
2. Tire Differences : Variations in diameter or grip.
3. Electrical : Motor driver output channels may have slight variance.
4. Solution : Adjust code calibration (different PWM offsets) or fix mechanical inconsistencies.

- 125.** A robotics student is enrolled in an introductory robotics course. Their first project is to learn the basics of kinematics by simulating a simple robotic arm in Tinkercad. They need to understand how revolute joints work and how to model link motion.

What components and process should the student follow to design an RR mechanism in Tinkercad?

Ans :

They should create two mechanical links (using cylinders or rectangular rods) and connect them with two revolute joints to serve as pivot points. Manually aligning these parts in Tinkercad and grouping them allows the student to simulate joint rotation and visualize the range of motion. This approach helps the student grasp kinematics fundamentals in a virtual, risk-free environment before transitioning to physical builds.

- 126.** A hobbyist who has previously built a stationary RR robotic arm now wishes to create a mobile robot that can navigate a room. They have basic components for movement but need to integrate them into a coherent design.

What additional components and design considerations are necessary to transition from a stationary RR mechanism to a wheeled mobile robot?

Ans :

They must add a chassis (a stable base), wheels with axles, and DC motors to provide locomotion, as well as integrate sensors (such as ultrasonic or IR) for obstacle detection.

The design should also include mounting spaces for a single-board computer (SBC) to process sensor inputs and control the motors.

This transition increases the system's complexity by requiring not only mechanical assembly for movement but also advanced control algorithms for navigation and sensor integration.

- 127.** A maker community is debating which single board computer (SBC) to use for their next project, a simple robot that reads sensor data and controls motors. They need an SBC that can handle basic programming and hardware control tasks.

Which SBCs are commonly used in simple robotic systems, and what roles do they perform?

Ans :

Common SBCs include the Raspberry Pi and Arduino. Raspberry Pi is preferred for more complex computational tasks, while Arduino excels at handling basic input/output (I/O) operations and real-time control of motors and sensors.

These boards run the code that processes sensor data, sends signals to actuators, and sometimes even communicates with external devices for remote control or data logging.

The choice between them depends on the project's demands—Arduino for straightforward control tasks and Raspberry Pi when additional processing power is required.

- 128.** An electronics hobbyist is exploring Tinkercad to design both the mechanical and electronic components of a robot. They plan to simulate circuits and visualize 3D models of their robot before assembling the physical system.

How does Tinkercad assist designers in building and testing simple robotic systems before moving to physical hardware?

Ans :

Tinkercad provides a browser-based platform that allows users to create 3D models of mechanical parts (like arms, chassis, and wheels) and simulate electronic circuits—including microcontrollers, sensors, and wiring.

This virtual environment enables rapid prototyping and iterative testing, where designers can experiment with different configurations and troubleshoot issues before committing to physical construction.

By simulating both mechanical and electronic aspects in one place, Tinkercad reduces development costs and risks while speeding up the design cycle.

- 129.** A robotics engineer is tasked with building a mobile robot that must operate reliably in various environments. An essential part of this project is ensuring the robot has a stable and sufficient power supply to drive both the motors and the control electronics.

When powering a robotic system with motors and sensors, what practical considerations must be taken into account regarding the power supply?

Ans :

The power supply must match the voltage and current requirements of both the motors and the SBC, often requiring regulated battery packs or power adapters that deliver stable power.

It is crucial to ensure that the supply has enough current capacity under load to prevent issues like motor stalling or component damage.

Proper power management is critical for ensuring reliable operation and safety, as fluctuations or insufficient power can lead to erratic behavior or hardware failure.

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- 130.** A team of makers is assembling a four-wheeled mobile robot for a robotics competition. They plan to use an L298N motor driver to interface between the microcontroller and the DC motors powering the robot.

Why is the inclusion of motor drivers such as the L298N essential, and how do they integrate with the SBC?

**Ans :**

Motor drivers like the L298N are essential because they safely bridge the gap between the low-power signals from the SBC and the higher power demands of the motors.

They allow the SBC to control motor speed and direction without exposing its sensitive circuits to high currents, effectively switching and regulating power.

This integration ensures precise control of motor functions and protects the microcontroller, thereby enhancing the robot's performance and reliability during operation.

- 131.** An autonomous mobile robot is being developed to navigate an indoor environment. To avoid collisions, the robot must detect obstacles in its path using appropriate sensors. For obstacle avoidance in a wheeled robot, which types of sensors are typically integrated, and what roles do they play?

**Ans :**

Distance sensors such as ultrasonic or infrared (IR) sensors are typically used to detect obstacles by measuring the distance to nearby objects.

These sensors provide real-time feedback, allowing the robot to adjust its path, stop, or perform evasive maneuvers to avoid collisions.

Integrating these sensors is crucial for enabling the robot to navigate safely and autonomously in dynamic and potentially unpredictable environments.

- 132.** A robotics project requires a systematic workflow from design to final deployment. The project involves designing components in Tinkercad, assembling hardware, coding, and iterative testing before the robot is fully operational. Outline the typical workflow from design to deployment when building a simple robotic system using Tinkercad and an SBC.

**Ans :**

The workflow starts with designing the mechanical

parts (such as the chassis, arms, and wheels) in Tinkercad, followed by simulating electronic circuits to plan sensor and microcontroller integration.

Next, the hardware is assembled, and code is written on the SBC to read sensor data and control the motors. Thorough testing and iterative refinement follow before final deployment.

This structured approach ensures that both mechanical and electronic components are well integrated, leading to a robust and reliable robotic system ready for real-world use.

- 133.** A robotics enthusiast is expanding a project from a stationary RR mechanism to a fully mobile robot. The added mobility introduces new challenges in control and navigation that were not present in the stationary design.

How does the transition from a stationary RR mechanism to a mobile robot affect the complexity of the coding and control systems?

**Ans :**

Transitioning to a mobile robot adds complexity by requiring code for locomotion control, such as differential drive algorithms, sensor-based navigation, and real-time error handling.

The control system must now process continuous sensor feedback to adjust motor speeds and directions dynamically, rather than just controlling a fixed arm movement.

This increased complexity necessitates rigorous testing and iterative refinement to ensure that the software and hardware work together seamlessly in varied environments.

- 134.** A safety-conscious robotics team is designing a robot that will operate in a public demonstration. Ensuring that the robot operates safely is as important as its functionality.

What safety and handling considerations must be addressed when constructing a simple robotic system to prevent mechanical and electrical failures?

**Ans :**

Designers must ensure that the robot has a stable base, secure wiring, and appropriate power regulation, along with protective circuits to prevent short-circuits or overloading components. Additionally, the use of proper motor drivers, robust structural materials, and thorough testing of all connections is essential to avoid mechanical failures or hazards during operation.

Addressing these safety measures is critical not only to protect the hardware but also to safeguard users and bystanders during demonstrations and real-world operation.

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# CHAPTER 6

## DECISION MAKING IN MACHINES/ COMPUTERS

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### SUMMARY

#### 1. AUTOMATED SYSTEM

Autonomous systems often utilize reinforcement learning (RL), a machine learning paradigm where agents learn through trial and error. Unlike automated systems, which follow a fixed set of rules, autonomous systems adjust their actions dynamically based on feedback. Example: A washing machine runs through predefined cycles.

#### 2. AUTONOMOUS SYSTEM

Can make decisions or adapt based on uncertain or changing environments (probabilistic). Example: A self-driving car uses sensors and AI to navigate.

##### 2.1 Deterministic vs. Probabilistic

1. Deterministic: Predictable outcomes; the same input always leads to the same output (e.g., an assembly line robot with fixed motions).
2. Probabilistic: Outcomes involve uncertainty; the system uses data or feedback to decide an action (e.g., a drone that must adjust flight due to wind changes).

#### 3. KEY DIFFERENCES

1. Rules vs. Adaptation: Automated systems follow strict, coded logic without deviation; autonomous systems learn from data or environment cues.
2. Complexity: Automated systems work well in controlled scenarios; autonomous ones handle complex or unpredictable situations.

#### 4. DECISION MAKING: HUMAN VS. MACHINE

##### 4.1 Human Decision Making

1. Often subjective, influenced by emotions, experience, biases.
2. Can handle fuzzy or abstract concepts

without explicitly defined rules.

3. Relies on context, intuition, and common sense.

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##### 4.2 Machine Decision Making

1. Primarily objective, based on algorithms and data.
2. Requires clearly defined inputs and measurable parameters.
3. Classification tasks (e.g., identifying objects) rely on pattern recognition or statistical methods.

##### 4.3 Object Classification by Humans vs. Machines

1. Humans: Instantly recognize objects by shape, color, prior knowledge.
2. Machines: Use features (size, color values, edges) or learned patterns via Machine Learning.
3. Computers may misclassify if data is incomplete or ambiguous; humans rely on context for clarity.

#### 5. MACHINE LEARNING (ML)

A subset of AI where machines learn from data rather than being explicitly programmed for every scenario. It involves algorithms that detect patterns in large datasets, enabling the system to improve with experience.

##### 5.1 Role of Data and Information

1. Data: Raw inputs (images, measurements, text).
2. Information: Meaningful insights or patterns derived from data.
3. ML models improve as they process more data (learning from examples).

##### 5.2 Steps in Machine Learning

1. Data Collection: Gather relevant and high-quality data.
2. Data Preprocessing: Clean, label, and format data for the algorithm.

3. Choosing/Designing an Algorithm: Select or create a model (e.g., decision tree, neural network).
4. Training: The algorithm “learns” patterns from training data.
5. Validation & Testing: Evaluate performance on unseen data, adjust parameters if needed.
6. Deployment: Use the trained model in real-world applications.

### 5.3 Importance of Programming and Algorithms in ML

1. Programming: Instructs computers on how to process data, train models, and make predictions.
2. Algorithms: Provide the mathematical or logical structure (e.g., linear regression, classification trees) that enables learning and decision-making.

### 5.4 Example: Fruit Sorting

1. Data: The system begins with data such as images or attributes of fruits, including characteristics like color, size, and shape.
2. Model: A classifier algorithm, for example, a simple neural network, is designed to analyze these features.
3. Training: The model is trained using labeled examples (e.g., “apple,” “banana,” “orange”) to learn the distinguishing patterns for each type of fruit.
4. Deployment: Once trained, the system can sort new fruits by matching their features to the learned patterns (e.g., a red fruit might be identified as an apple, while an elongated shape might indicate a banana).

include sensors, their core logic remains fixed, in contrast to autonomous systems that make probabilistic decisions in uncertain environments.

2. Which term best describes a self-driving car that learns from traffic data and adjusts its driving accordingly?
  - (a) Automated
  - (b) Deterministic
  - (c) Autonomous
  - (d) Static

Ans :

SQP 2021

(c) Autonomous  
Self-driving cars use sensor data, machine learning models, and real-time feedback to drive. They adapt to changing roads, weather, or obstacles. This reflects autonomous behavior rather than straightforward automation, which follows rigid, unchanging rules.

3. Human decision making is generally considered \_\_\_\_\_, while machine decision making is \_\_\_\_\_.
  - (a) Fast; always slow
  - (b) Subjective; objective
  - (c) Predictable; random
  - (d) Error-free; prone to mistakes

Ans :

COMP 2023

(b) Subjective; objective  
Humans incorporate personal experience, emotions, and biases (subjective). Machines follow mathematical models or algorithms, typically ignoring emotions or context beyond their data (objective). While humans can use intuition, machines rely on quantifiable parameters.

4. Which of the following is an example of a deterministic process?
  - (a) Weather forecasting
  - (b) A basic calculator performing  $2 + 2 = 4$
  - (c) Stock price prediction
  - (d) A robot navigating an unknown maze

Ans :

MAIN 2024

(b) A basic calculator performing  $2 + 2 = 4$   
Deterministic means the same input yields the same output reliably. A calculator's arithmetic is entirely predictable. Weather forecasting and stock predictions are inherently uncertain (probabilistic). A robot in an unknown environment must adapt, also involving uncertainty.

## MULTIPLE CHOICE QUESTION

1. An automated system primarily operates under \_\_\_\_\_.
  - (a) Probability calculations
  - (b) Fixed rules and instructions
  - (c) Emotional reasoning
  - (d) Uncertain feedback loops

Ans :

MAIN 2025

(b) Fixed rules and instructions  
Automated systems rely on predefined logic or routines. They do not self-adapt to new conditions beyond their programming. While they may

5. In object classification, machines primarily rely on \_\_\_\_\_.  
 (a) Intuition and feelings  
 (b) Physical trial-and-error with no data  
 (c) Pattern recognition from data or features  
 (d) Blind guessing

Ans :

SQP 2013

(c) Pattern recognition from data or features  
 Machine classification algorithms extract features (color, texture, shape) from input data. They match these features to learned patterns. Unlike humans, who may use intuition or context clues, machines use systematic pattern recognition from training data.

6. Which statement best describes “Machine Learning”?  
 (a) It’s a manual labeling process  
 (b) It’s a subset of AI where systems learn patterns from data  
 (c) It requires explicit rules for every outcome  
 (d) It never involves algorithms

Ans :

COMP 2016

(b) It’s a subset of AI where systems learn patterns from data  
 Machine Learning focuses on data-driven pattern recognition. The system “learns” a model from examples rather than needing rules for each outcome. It’s part of AI but not merely manual labeling—though labeled data can be crucial for supervised learning. Algorithms are central in ML.

7. When a system uses sensor inputs to adapt its actions in real time under uncertainty, it is considered \_\_\_\_\_.  
 (a) Automated  
 (b) Autonomous  
 (c) Obsolete  
 (d) Error-free

Ans :

MAIN 2016

(b) Autonomous  
 Adapting to uncertain or variable environments is the hallmark of autonomy. Such a system makes decisions beyond a fixed sequence of actions, employing feedback loops and probabilistic reasoning. Automated systems, in contrast, do not significantly adjust behavior beyond set parameters.

8. Which of the following is NOT a typical step in a machine learning process?

- (a) Gathering data  
 (b) Preprocessing data  
 (c) Setting random outputs without training  
 (d) Evaluating model performance

Ans :

SQP 2015

(c) Setting random outputs without training  
 ML typically includes data collection, preprocessing, choosing an algorithm, training, and evaluating on test data. Producing random outputs without training is the opposite of ML’s goal, which is to learn meaningful patterns for accurate predictions or classifications.

9. Deterministic systems have outcomes that are \_\_\_\_\_.  
 (a) Exactly the same given the same inputs  
 (b) Dependent on probabilistic modeling  
 (c) Always random  
 (d) Derived from emotional bias

Ans :

COMP 2019

(a) Exactly the same given the same inputs  
 In deterministic systems, the same initial conditions always produce the same results. There is no randomness or reliance on uncertain data. Automated assembly-line robots performing the same routine each cycle exemplify determinism.

10. Machine decision making in classification tasks is often based on \_\_\_\_\_.  
 (a) Hunches or guesses  
 (b) Explicit emotional responses  
 (c) Learned statistical patterns from training data  
 (d) Coin flips

Ans :

MAIN 2006

(c) Learned statistical patterns from training data  
 Classification models learn from labeled examples, extracting statistical features and forming rules to categorize new inputs. Emotions or random chance are not typically part of machine classification unless specifically programmed for such randomness.

11. Fruit sorting using Machine Learning might rely on features such as \_\_\_\_\_.  
 (a) Emotional reaction to color  
 (b) Random color guessing  
 (c) Physical damage to each piece  
 (d) Color, shape, and size data for each fruit

Ans :

SQP 2012

(d) Color, shape, and size data for each fruit

ML-based fruit sorting can measure color intensity, dimensions, or shape. A classifier is trained on these labeled attributes (“banana,” “apple,” etc.) to categorize new fruits. Emotional factors or random guesses do not factor into a properly trained ML system.

12. Which of the following is a characteristic of a purely automated system?
- Adapts to unknown conditions on its own
  - Learns over time with new data
  - Operates strictly on predefined, unchanging rules
  - Uses sensor feedback to shift strategies probabilistically

Ans : COMP 2018

(c) Operates strictly on predefined, unchanging rules

In purely automated systems, the logic is predefined, with no built-in mechanism to adapt or learn from new circumstances. They do precisely what they’re programmed for, repeating the same instructions unless manually updated.

13. Human classification of objects often relies on \_\_\_\_\_.  
 (a) Strict numeric rules only  
 (b) Context, experience, and intuition  
 (c) Predefined statistical models  
 (d) Probability alone

Ans : MAIN 2011

(b) Context, experience, and intuition

Humans use a mixture of experience, contextual understanding, and sometimes intuition to classify objects. While we can apply logic or memory, there’s a subjective element. Machines, in contrast, rely more on explicit numeric or algorithmic rules trained from data.

14. When a machine sorts fruits by analyzing thousands of labeled images, it is using \_\_\_\_\_.  
 (a) Manual programming of shape rules only  
 (b) Emotional inference  
 (c) Machine learning on a dataset  
 (d) Random mechanical selection

Ans : SQP 2009

(c) Machine learning on a dataset

Feeding the machine thousands of labeled images allows a learning algorithm to identify patterns (color, shape) corresponding to specific fruits. This exemplifies supervised ML. Over time, the algorithm generalizes to classify unseen

fruit images. Manual shape rules or emotional inferences are not typical.

15. Which example highlights a system with a probabilistic approach?
- A traffic light timer set to 90 seconds
  - A calculator returning 8 when you type 4+4
  - A weather prediction model that updates forecasts
  - A metal stamping machine with fixed cycles

Ans : COMP 2014

(c) A weather prediction model that updates forecasts

Weather forecasts incorporate uncertain data (temperature changes, atmospheric variables) to generate predictions, often with probabilities. Timers and calculators are deterministic, and a stamping machine repeats a set cycle. Thus, weather forecasting is a prime example of a probabilistic approach.

16. If a system modifies its rules as it encounters new data, this indicates it is \_\_\_\_\_.  
 (a) Automated  
 (b) Autonomous or learning-based  
 (c) Completely deterministic  
 (d) Lacking any feedback

Ans : MAIN 2007

(b) Autonomous or learning-based

Systems that dynamically change or refine their decision logic based on new information are indicative of autonomy or ML. They do not remain static but incorporate additional data for improved accuracy or behavior. Automated systems remain fixed in their programming.

17. One difference between automated and autonomous systems is that autonomous systems \_\_\_\_\_.  
 (a) Never require sensors  
 (b) Do not require training  
 (c) Can handle uncertain environments and adapt  
 (d) Are always simpler to design

Ans : SQP 2017

(c) Can handle uncertain environments and adapt  
 Autonomous systems use sensors and feedback loops to adapt. They manage unpredictable environments by making probabilistic or learned decisions. Automated systems, in contrast, follow predefined instructions that assume stable, predictable conditions.

18. In machine learning, “training data” is \_\_\_\_\_.  
 (a) A set of instructions telling the machine exactly how to respond in all cases  
 (b) The labeled examples from which an algorithm learns patterns  
 (c) Irrelevant to a model’s performance  
 (d) A random set of equations

Ans :

COMP 2010

(b) The labeled examples from which an algorithm learns patterns

Training data contains labeled examples (e.g., fruit images with correct labels). The ML model “learns” the relationship between inputs (features) and outputs (labels). This learning process is essential to the model’s predictive abilities. Without training data, the model cannot generalize well.

19. Which is typically TRUE about human decision making?  
 (a) It’s entirely free of bias  
 (b) It uses only mathematical calculations  
 (c) It can incorporate subjective judgments and personal experiences  
 (d) It never changes with context

Ans :

MAIN 2008

(c) It can incorporate subjective judgments and personal experiences

Humans factor in experiences, biases, context, and possibly emotions in decision-making. Because of these subjective influences, two people can reach different conclusions with the same data. Machine decisions, on the other hand, are more rigidly tied to algorithms and input data.

20. Machine learning algorithms require \_\_\_\_\_.  
 (a) Zero data to function  
 (b) Extensive labeled or unlabeled datasets  
 (c) Pure emotional logic  
 (d) Manual computation of each step by the user

Ans :

SQP 2022

(b) Extensive labeled or unlabeled datasets  
 ML algorithms rely on data—either labeled (supervised learning) or unlabeled (unsupervised learning). The quality and quantity of data directly affect model performance. Emotional or purely manual computations are not typical in ML, which is largely automated after algorithm setup.

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21. A fruit-sorting machine that uses color sensors and pre-defined thresholds (e.g., red > 80% for apples) is an example of \_\_\_\_\_.  
 (a) Probabilistic autonomous system  
 (b) Automated system based on fixed rules  
 (c) Fully self-driving approach  
 (d) Emotional-based classification

Ans :

COMP 2025

(b) Automated system based on fixed rules  
 If the system is simply measuring color intensity and sorting based on a static threshold (e.g., if red > 80% → apple), it’s deterministic automation. There is no continuous learning or adaptation from new data, only a set cutoff value coded in.

22. A system that uses neural networks to classify new fruits after learning from past data is an example of \_\_\_\_\_.  
 (a) Manual thresholding  
 (b) Machine learning-based classification  
 (c) A purely mechanical approach  
 (d) Guesswork without data

Ans :

MAIN 2021

(b) Machine learning-based classification  
 Neural networks learn from labeled examples, adjusting internal weights to recognize features. Thus, they can classify new fruit images or sensor readings based on learned patterns. This is the core of ML, not a basic threshold or guess.

23. When referencing “probabilistic” decision making, it implies that decisions are made \_\_\_\_\_.  
 (a) With guaranteed outcomes  
 (b) Based on fixed, unchanging rules  
 (c) Using chance, uncertainty, or likelihoods drawn from data  
 (d) Without any rational basis

Ans :

SQP 2023

(c) Using chance, uncertainty, or likelihoods drawn from data

Probabilistic implies incorporating uncertainty into the decision process. The system calculates probabilities (e.g., there’s a 70% chance the input is an apple). These uncertain or data-driven methods contrast with rigid deterministic outcomes.

24. A purely deterministic automated arm in a factory will \_\_\_\_\_.  
 (a) Adjust to random changes in the environment automatically

- (b) Follow pre-programmed paths exactly, regardless of disruptions
- (c) Use neural networks to interpret changes
- (d) Randomly stop working if data is incomplete

Ans : COMP 2024

- (b) Follow pre-programmed paths exactly, regardless of disruptions

Deterministic automation means the arm repeatedly follows a set routine (e.g., pick, place, weld). If disruptions occur outside its predefined instructions, it has no built-in adaptation. Autonomous or ML-based arms, by contrast, might sense changes and modify behavior.

25. Machine learning's success heavily depends on \_\_\_\_\_.

- (a) The mechanical structure only
- (b) Large amounts of relevant, high-quality data
- (c) Intuitive leaps from the computer's emotions
- (d) Overlooking algorithmic accuracy

Ans : MAIN 2013

(b) Large amounts of relevant, high-quality data  
ML models need comprehensive and clean data to accurately learn patterns. The more relevant examples they see, the better they generalize. Mechanical structures and emotional concepts are irrelevant in purely computational ML, while ignoring accuracy undermines the entire process.

26. Human decision-making may be prone to bias, whereas machine decision-making is prone to \_\_\_\_\_.

- (a) Perfect correctness
- (b) Zero error
- (c) Emotional outbursts
- (d) Bias from training data or algorithms

Ans : SQP 2016

(d) Bias from training data or algorithms  
Machines can exhibit biased results if their training data or algorithms are biased. For instance, if a dataset lacks certain categories or is skewed, the model's decisions reflect those biases. They don't "feel," but they replicate data-driven biases.

27. Which statement about automation and autonomy is TRUE?

- (a) Autonomy involves learning or adapting in uncertain scenarios
- (b) Automation strictly requires AI
- (c) Automated systems run on random logic
- (d) Autonomy uses manual step-by-step instructions

Ans :

COMP 2015

- (a) Autonomy involves learning or adapting in uncertain scenarios

Autonomous systems can handle novel or changing conditions by learning or adapting. Automation is not always AI-based; it can be simpler deterministic logic. Hence, option (a) accurately defines autonomy as dealing with uncertain environments through adaptability.

28. In a fruit-sorting ML example, the "training" phase means the system is \_\_\_\_\_.

- (a) Simply storing random images without labels
- (b) Learning to associate image features with fruit categories
- (c) Pre-programmed with thresholds
- (d) Not using any data

Ans :

MAIN 2019

- (b) Learning to associate image features with fruit categories

Training in ML means the model sees labeled samples (e.g., "apple," "banana" with corresponding images or sensor data). By processing these examples, the model's parameters adjust to associate specific features with categories. In threshold-based systems, no training is needed, just static definitions.

29. Which factor best exemplifies a subjective aspect of human decision making?

- (a) Hard-coded color threshold
- (b) Emotional influence or personal past experiences
- (c) Statistical regression
- (d) Strict sensor-based cutoffs

Ans :

SQP 2006

- (b) Emotional influence or personal past experiences

Humans often rely on prior experiences or emotions when making choices, which introduces subjectivity. Machines, by contrast, base decisions on coded logic or learned statistical relationships. Emotional considerations or personal backgrounds do not factor directly into machine algorithms.

30. Why is programming essential in teaching computers subjective decision making?

- (a) Computers require logic or algorithms to process data and emulate aspects of subjective tasks
- (b) Computers can guess decisions randomly
- (c) It allows computers to develop emotions
- (d) No code is needed for machine learning

Ans :

COMP 2012

(a) Computers require logic or algorithms to process data and emulate aspects of subjective tasks

Even “subjective” tasks (like fruit sorting or image recognition) require code that defines how data is processed, how the model learns, and how to handle uncertainty. Computers lack inherent intuition, so algorithms must simulate or approximate human-like classification using data and statistical methods.

- 31.** A residential washing machine runs through predetermined cycles every time it’s switched on without any external feedback.

Is this system best described as automated or autonomous?

- (a) Autonomous system
- (b) Automated system
- (c) Probabilistic system
- (d) Adaptive system

Ans :

MAIN 2018

- (b) Automated system

In this case, the washing machine operates based on fixed instructions without adapting to external conditions. Automated systems follow strict, predetermined rules, resulting in consistent, deterministic outcomes. Unlike autonomous systems that adjust based on feedback, this device performs the same cycle every time, ensuring reliable, predictable operation effectively.

- 32.** A self-driving car navigates busy urban streets by processing sensor data and adjusting its path in real time.

How is this system best characterized?

- (a) Automated system
- (b) Deterministic system
- (c) Autonomous system
- (d) Fixed-cycle system

Ans :

SQP 2011

- (c) Autonomous system

In this case, the self-driving car uses sensors and artificial intelligence to make real-time decisions. Autonomous systems adapt to changing environments, employing probabilistic methods. Unlike automated systems with fixed rules, the vehicle continuously adjusts its behavior to unpredictable traffic conditions, ensuring safe, dynamic navigation and optimal performance under variable circumstances.

- 33.** An assembly line robot precisely places components on a circuit board, repeating the same sequence every cycle without variation.

Which operational characteristic best describes this robot?

- (a) Probabilistic operation
- (b) Autonomous adaptation
- (c) Automated operation
- (d) Human-guided decision-making

Ans :

COMP 2014

- (c) Automated operation

This assembly robot follows a fixed sequence of predefined instructions, leading to consistent, repeatable results. Its deterministic behavior exemplifies an automated system, where every input produces the same output. There is no adaptation to environmental changes, ensuring reliability in controlled settings where predictability and efficiency are paramount for production tasks.

- 34.** A drone flying in windy conditions adjusts its route in real time by processing sensor data and AI algorithms.

Which description best fits the drone’s decision-making process?

- (a) Deterministic and automated
- (b) Probabilistic and autonomous
- (c) Manually controlled
- (d) Fixed-cycle programmed

Ans :

MAIN 2007

- (b) Probabilistic and autonomous

In this case, the drone uses sensor feedback to adapt its flight path when encountering wind variations. Its decision-making involves probabilistic outcomes and autonomous adjustments rather than following fixed rules. This adaptive capability allows the drone to navigate uncertainty dynamically, ensuring safe and efficient flight under fluctuating environmental conditions effectively.

- 35.** A fruit sorting machine employs a trained classifier to distinguish between apples, bananas, and oranges based on image features.

What role does machine learning play in this system?

- (a) It hard-codes sorting rules
- (b) It learns patterns from data to classify fruits
- (c) It randomly assigns fruit categories
- (d) It relies solely on manual calibration

Ans :

SQP 2017

(b) It learns patterns from data to classify fruits  
In this case, machine learning algorithms analyze visual features such as color, size, and shape from fruit images. By training on labeled examples, the system identifies and classifies fruits accurately. This learning process enables dynamic adaptation to new inputs, improving classification performance over time rather than relying on rigid, preprogrammed sorting rules.

- 36.** A company uses an email classifier that sorts messages as spam or not spam by analyzing specific input features.

What distinguishes machine decision-making in this context from human decision-making?

- (a) Machines rely on subjective intuition
- (b) Machines require clearly defined inputs and algorithms
- (c) Humans follow deterministic rules
- (d) Machines ignore measurable data

Ans :

COMP 2010

- (b) Machines require clearly defined inputs and algorithms

In this example, the spam classifier depends on predefined algorithms and statistical methods to evaluate email features objectively. Unlike human decision-making—where context, emotions, and abstract reasoning influence outcomes—machine decision-making is strictly based on quantitative inputs. This objective approach ensures consistent, reproducible classification provided the data is accurate and complete consistently.

- 37.** A smart traffic management system analyzes sensor data to adjust traffic signal timings dynamically at a busy intersection.

Which system characteristic best describes this application?

- (a) Deterministic and automated
- (b) Probabilistic and autonomous
- (c) Manual and preprogrammed
- (d) Fixed-cycle operation

Ans :

MAIN 2008

- (b) Probabilistic and autonomous

In this smart traffic management system, sensor data is analyzed to adjust signal timings based on real-time conditions. The system uses probabilistic decision-making and autonomous control, allowing it to respond dynamically to traffic flows. This adaptive approach improves efficiency compared to fixed, deterministic systems, ensuring smoother traffic management overall effectively.

- 38.** A retail company deploys a service robot at its information desk that handles customer queries using pre-programmed responses.

What type of system best describes this service robot?

- (a) Autonomous system
- (b) Automated system
- (c) Probabilistic system
- (d) Adaptive system

Ans :

SQP 2022

- (b) Automated system

In this retail scenario, the service robot operates by following fixed instructions and predefined rules to manage customer queries. Its deterministic behavior produces predictable outcomes. Unlike autonomous systems that adapt to unexpected situations, this robot executes a set script, ensuring consistent performance in controlled environments where variability is minimal and reliability is prioritized.

- 39.** A logistics company uses a drone for package delivery that adjusts its flight route based on weather conditions.

Which decision-making model does the drone most likely employ?

- (a) Deterministic
- (b) Probabilistic
- (c) Manual override
- (d) Fixed schedule

Ans :

COMP 2021

- (b) Probabilistic

In this logistics application, the drone uses sensor feedback to adapt its route dynamically. This probabilistic decision-making model accommodates uncertainty and variability, unlike deterministic systems relying on fixed inputs. The drone's ability to adjust for weather changes exemplifies an autonomous approach designed to optimize delivery efficiency under fluctuating conditions effectively.

- 40.** A tech startup develops an AI model for object classification, comparing human intuition with machine learning techniques in a prototype sorting system.

What is a primary limitation of machine decision-making compared to human decision-making?

- (a) Subjectivity and bias
- (b) Dependence on clearly defined inputs and data quality
- (c) Superior pattern recognition
- (d) Ability to handle abstract concepts

Ans :

MAIN 2023

(b) Dependence on clearly defined inputs and data quality

Machine decision-making relies on algorithms processing clearly defined inputs and high-quality data. Unlike human intuition, machines lack the context and abstract reasoning abilities inherent in human decision-making. This dependence on structured data can lead to misclassifications if inputs are incomplete or ambiguous, highlighting a limitation compared to human cognitive flexibility effectively.

**41.** Which statement about deterministic systems is correct?

- (a) They yield random results every time
- (b) They adapt in uncertain conditions
- (c) They produce consistent outputs for the same inputs
- (d) They run on emotional responses

Ans :

SQP 2024

(c) They produce consistent outputs for the same inputs

Deterministic systems always provide the same outcome if conditions and inputs remain identical. Random or adaptive behaviors are characteristic of probabilistic or autonomous systems, and emotional responses apply to humans, not deterministic machines. Hence, (c) is correct.

**42.** Which statement regarding human vs. machine decision making is correct?

- (a) Humans rely solely on numeric data
- (b) Machines handle only emotional cues
- (c) Humans can be subjective, while machines are primarily objective
- (d) Machines never require data

Ans :

COMP 2013

(c) Humans can be subjective, while machines are primarily objective

Humans bring subjective elements like emotion or context, whereas machines rely on objective algorithms and data. Though machine decisions can reflect data bias, they do not “feel.” The other options incorrectly swap or ignore the fundamental differences between human intuition and machine logic.

**43.** Which statement about automated and autonomous systems is correct?

- (a) Automated systems change rules on their own
- (b) Autonomous systems handle uncertainty by

adapting their behavior

- (c) Autonomous systems never rely on data
- (d) Automated systems always use neural networks

Ans :

MAIN 2016

(b) Autonomous systems handle uncertainty by adapting their behavior

Autonomous systems can handle new or uncertain scenarios, adapting via feedback loops or machine learning. Automated systems are typically rule-bound. Neural networks or data reliance may or may not be used, but it's the ability to adapt that differentiates autonomy from automation.

**44.** Which statement about machine learning is correct?

- (a) It's based on emotional judgments
- (b) It never uses data
- (c) It learns patterns from data to make predictions or classifications
- (d) It is always more accurate than human decisions

Ans :

SQP 2015

(c) It learns patterns from data to make predictions or classifications

ML algorithms identify patterns in training data, then apply these patterns to predict or classify new examples. They do not depend on emotions; rather, they require relevant datasets. Accuracy can vary; it's not guaranteed to surpass human performance, especially with poor data or design.

**45.** Choose the correct statement about object classification by machines.

- (a) Machines rely solely on emotional cues
- (b) Machines use statistical or algorithmic methods to classify inputs
- (c) Machines have innate intuition
- (d) Machines never misclassify objects

Ans :

COMP 2019

(b) Machines use statistical or algorithmic methods to classify inputs

Classification algorithms revolve around data and pattern recognition. Computers do not rely on “emotional” or “intuitive” cues. They can and do misclassify if the model or data is imperfect. Hence, the correct statement highlights the statistical or algorithmic nature of machine classification.

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46. Which statement correctly contrasts deterministic and probabilistic approaches?
- Deterministic yields multiple possible outcomes; probabilistic yields a single outcome
  - Deterministic changes output with every run; probabilistic is always the same
  - Deterministic is fixed outcome for a given input; probabilistic involves uncertainty
  - Both are purely guesswork

Ans :

MAIN 2006

(c) Deterministic is fixed outcome for a given input; probabilistic involves uncertainty  
Deterministic means a fixed outcome if inputs remain constant; probabilistic means uncertainty is modeled, leading to likelihoods or multiple possible outcomes. The other statements confuse or invert these definitions. Thus, (c) accurately captures each approach's essence.

47. Which is the correct statement about fruit sorting using ML?
- It requires no data
  - It uses labeled examples to train the classifier
  - It always sorts perfectly from the first attempt
  - It is not related to AI

Ans :

SQP 2012

(b) It uses labeled examples to train the classifier  
ML-based sorting typically uses labeled data—for instance, images or sensor readings with known fruit types. The model learns patterns during training. Perfect sorting is not guaranteed, especially initially. ML classification is indeed a branch of AI.

48. Which statement about human decision making is correct?
- It always follows purely numerical data
  - It can incorporate personal biases and context
  - It is purely deterministic
  - It relies only on an algorithm

Ans :

COMP 2018

(b) It can incorporate personal biases and context  
Humans frequently bring subjectivity—preferences, biases, context—to decisions. This differs from purely numerical or deterministic models. The other options incorrectly suggest exclusively data-driven or algorithmic processes that apply more to machine logic than human cognition.

49. Which is the correct statement about programming in machine learning?

- It provides the algorithms to process and learn from data
- It is unnecessary if data is available
- It is replaced by emotional logic
- It always leads to guaranteed 100% accurate models

Ans :

MAIN 2011

(a) It provides the algorithms to process and learn from data

ML relies on coded algorithms (e.g., neural networks, decision trees) to interpret data. If no programming or algorithmic framework is provided, the machine cannot learn. Emotional logic is not relevant, and absolute accuracy is never guaranteed. Hence, (a) is correct.

50. Which statement about automated vs. autonomous systems is correct?

- Automated systems never use any sensors
- Autonomous systems can learn or adjust decisions based on new data
- Automation and autonomy are the same
- Autonomous systems are always simpler to build

Ans :

SQP 2009

(b) Autonomous systems can learn or adjust decisions based on new data

Autonomous systems handle changes via feedback or learning (e.g., adjusting speed if obstacles appear). Automated systems might use sensors but do not adapt their logic without reprogramming. They are distinct concepts, and autonomy often is more complex rather than simpler.

## ASSERTION AND REASON

51. **Assertion (A)** : Automated systems can adapt to unforeseen environments.

**Reason (R)** : Automated systems typically follow deterministic rules without changing their behavior.

**Options:**

- Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- Both Assertion and Reason are correct, but Reason is not the correct explanation.
- Assertion is correct, but Reason is incorrect.
- Assertion is incorrect, but Reason is correct.

Ans :

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because automated systems generally cannot adapt to brand-new scenarios. The reason is correct in describing them as following deterministic instructions. If the environment changes significantly, an automated system cannot self-modify. Thus, (d) applies: Assertion is wrong, but Reason is correct.

- 52. Assertion (A) :** Autonomous systems often handle probabilistic data.

**Reason (R) :** They must make decisions in uncertain conditions using sensor feedback and learned models.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are true, and the reason explains why. Autonomous systems incorporate sensor readings and might not always have exact outcomes. They rely on probabilities or learned patterns to choose actions in uncertain environments. Hence, the reason directly supports the assertion.

- 53. Assertion (A) :** Humans and machines classify objects identically.

**Reason (R) :** Humans use intuition and experience; machines use data-driven algorithms.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect—humans and machines often differ in how they classify objects. The reason is correct: humans rely on experience and context, whereas machines rely on numeric features and patterns. So, (d) is correct: the assertion is wrong, but the reason is right.

- 54. Assertion (A) :** Machine learning algorithms can detect patterns from large datasets.

**Reason (R) :** They adjust parameters based on training examples to improve classification or prediction accuracy.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both the assertion and reason are correct, and the reason explains how ML algorithms detect patterns—by refining parameters after seeing training data. The iterative adjustment process leads to improved accuracy, showing direct cause-and-effect.

- 55. Assertion (A) :** Deterministic systems rely on fixed logic, so outcomes are predictable.

**Reason (R) :** They use static instructions that do not vary with changing inputs.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(c) Assertion is correct, but Reason is incorrect. The assertion is correct in stating deterministic systems yield predictable outcomes. However, the reason is incorrect because deterministic systems can still handle different inputs according to fixed logic. The same input always yields the same result, but changing inputs produce consistently defined outputs—not ignoring them.

- 56. Assertion (A) :** If a fruit-sorting model uses thousands of labeled examples, it's an example of machine learning.

**Reason (R) :** Machine learning requires no labeled data.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(c) Assertion is correct, but Reason is incorrect. The assertion is correct: large labeled datasets are typical in supervised ML. The reason is incorrect because supervised learning specifically depends on labeled data. Thus, we have a correct assertion but an incorrect reason.

- 57. Assertion (A) :** Automated assembly lines can switch to new products instantly without reprogramming.

**Reason (R) :** Automated systems follow rigid, predetermined programs.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect—automated lines typically need reprogramming or reconfiguration to handle new products. The reason is correct in describing automated systems as rigid. So, (d) applies: the assertion is wrong, but the reason about rigidity is right.

- 58. Assertion (A) :** Human decision making is purely objective.

**Reason (R) :** Humans can apply subjective experiences to interpret situations.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect because human decision making often includes emotions, biases, and subjectivity. The reason is correct—humans do use personal experiences. Therefore, (d) is correct: the assertion is wrong, but the reason statement is correct.

- 59. Assertion (A) :** Machine learning fruit sorting uses hand-coded color thresholds.

**Reason (R) :** ML fruit sorting typically adapts to new fruits by learning from labeled datasets.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect—hand-coded color thresholds are more deterministic or automated than ML-based. The reason is correct: ML typically involves adaptive learning from examples. So, (d) is correct: the assertion is false, the reason is true.

- 60. Assertion (A) :** Probabilistic systems never rely on fixed rules.

**Reason (R) :** Probabilistic systems incorporate uncertainty and can update their assessments as new data arrives.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(c) Assertion is correct, but Reason is incorrect. Because some probabilistic systems still have frameworks or rules, but they accommodate uncertain data. The reason is correct, describing how they handle uncertainty and can revise outputs. Hence, the assertion is wrong, but the reason is valid.

## STATEMENT BASED QUESTIONS

- 61.** Consider the following statements about automated and autonomous systems:

1. An automated system operates according to fixed rules or instructions and is deterministic.
2. An autonomous system operates solely based on fixed, preprogrammed rules without adapting to changes in the environment.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

Ans :

- (a) Only statement 1 is correct.

Automated systems follow fixed rules (deterministic), as described. In contrast, autonomous systems are designed to adapt and make decisions in changing or uncertain environments; they do not operate solely on fixed rules.

**62.** Consider the following statements regarding deterministic and probabilistic systems:

1. In a deterministic system, the same input always produces the same output.
2. In a probabilistic system, outcomes involve uncertainty and the same input may lead to different outputs due to data or environmental feedback.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

Ans :

- (c) Both statements 1 and 2 are correct.

Deterministic systems yield predictable outcomes with the same input always resulting in the same output. Probabilistic systems, however, incorporate uncertainty and variability in outcomes even when the input is the same.

**63.** Consider the following statements about the key differences between automated and autonomous systems:

1. Automated systems rely on strict, pre-coded logic and do not deviate from predefined rules.
2. Autonomous systems are designed to adapt to complex or unpredictable situations by learning from data or environmental cues.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

Ans :

- (c) Both statements 1 and 2 are correct.

The material clearly distinguishes that automated systems strictly follow set rules, while autonomous systems are built to adapt and make decisions based on real-time data and environmental changes.

**64.** Consider the following statements about decision making by humans versus machines:

1. Human decision making is often subjective and influenced by emotions, experience, and context.
2. Machine decision making is primarily objective and relies on algorithms and clearly defined inputs.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

Ans :

- (c) Both statements 1 and 2 are correct.

Humans rely on intuition, context, and subjective factors when making decisions, whereas machines use algorithms and quantitative data to make objective decisions.

**65.** Consider the following statements regarding object classification by humans and machines:

1. Humans instantly recognize objects using shape, color, and prior knowledge, often relying on context.
2. Machines classify objects using features such as size, color values, and edges but may misclassify if the data is incomplete or ambiguous.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

Ans :

- (c) Both statements 1 and 2 are correct.

Both statements accurately describe the differences in how humans and machines classify objects. Humans use context and intuition, while machines rely on measurable features and learned patterns.

**66.** Consider the following statements about Machine Learning (ML):

1. Machine Learning is a subset of AI where machines learn from data rather than being explicitly programmed for every scenario.
2. Machine Learning involves the use of algorithms that automatically identify patterns in large datasets.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

Ans :

(c) Both statements 1 and 2 are correct.

ML is defined as a branch of AI focused on learning from data using algorithms that detect patterns, making both statements correct.

**67.** Consider the following statements about the roles of data and information in ML:

1. In ML, “data” refers to the raw inputs such as images, measurements, or text.
2. “Information” is the meaningful insight or pattern derived from processing the raw data, and ML models improve as they process more examples.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

Ans :

(c) Both statements 1 and 2 are correct.

The material distinguishes raw data from the information (insights) obtained after processing the data, and it notes that ML models improve with more data.

**68.** Consider the following statements about the steps in the Machine Learning process:

1. Data preprocessing is a critical step that involves cleaning, labeling, and formatting the data before training the model.
2. The training phase of ML involves the algorithm learning patterns exclusively from the testing dataset.

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

Ans :

(a) Only statement 1 is correct.

Data preprocessing is essential for preparing the data. However, training is performed using the training dataset—not the testing dataset, which is reserved for evaluation.

**69.** Consider the following statements regarding programming and algorithms in ML:

1. Programming is essential in ML as it instructs computers on how to process data, train models, and make predictions.
2. Algorithms in ML provide the mathematical and logical framework that enables machines to learn from data and make decisions.

(a) Only statement 1 is correct.

(b) Only statement 2 is correct.

(c) Both statements 1 and 2 are correct.

(d) Neither statement 1 nor 2 is correct.

Ans :

(c) Both statements 1 and 2 are correct.

Both programming and algorithms are fundamental to ML; programming implements the process while algorithms form the backbone of the learning and decision-making structure.

**70.** Consider the following statements based on the fruit sorting example:

1. In the fruit sorting example, the data includes images or attributes of fruits such as color, size, and shape.

2. In the fruit sorting example, deployment refers to the phase where the model is trained using labeled examples like “apple,” “banana,” and “orange.”

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

Ans :

(a) Only statement 1 is correct.

In the fruit sorting example, data indeed refers to the raw attributes of the fruits. However, deployment is the phase where the trained model is applied to sort new fruits—not the training phase where labeled examples are used.

## PICTURE BASED QUESTIONS

**71.** Observe the images:



1. A washing machine running a predefined cycle.
  2. A self-driving car navigating around an obstacle.
- Which statement best describes the difference?
- (a) Both systems follow strict, coded logic.
  - (b) The washing machine is autonomous because it runs independently.
  - (c) The washing machine is automated, while the self-driving car is autonomous.
  - (d) Neither system makes independent decisions.

Ans :

(c) The washing machine is automated, while the self-driving car is autonomous.

Automated systems follow fixed rules without adapting, like a washing machine. Autonomous systems use sensors and AI to adjust actions based on the environment, like a self-driving car.

**72.** Look at the images:

1. An assembly line robot performing repetitive motions.
2. A delivery drone adjusting its flight due to wind.



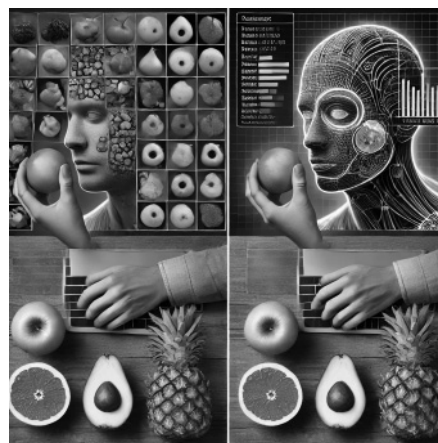
Which of the following is true?

- (a) Both systems are deterministic.
- (b) The drone operates in a deterministic manner.
- (c) The assembly line robot follows deterministic rules, while the drone operates probabilistically.
- (d) The assembly line robot makes independent decisions.

Ans :

(c) The assembly line robot follows deterministic rules, while the drone operates probabilistically. Deterministic systems have predictable outputs (e.g., an assembly robot). Probabilistic systems adjust to uncertainties (e.g., a drone adjusting to wind changes).

**73.** Human vs. Machine Object Classification  
Consider the images:



1. A person instantly recognizing a fruit.
2. A computer analyzing an image of a fruit using pattern recognition.

What is the main difference in classification?

- (a) Humans rely on context and intuition, while machines use measurable features.
- (b) Machines classify objects instantly, while humans take longer.
- (c) Both humans and machines classify objects in the same way.
- (d) Humans misclassify objects more than machines.

Ans :

(a) Humans rely on context and intuition, while machines use measurable features.

Humans use experience and intuition to classify objects, while machines rely on defined features (color, size, edges) and learned patterns, sometimes leading to misclassification if data is unclear.

**74.** Machine Learning in Fruit Sorting



Look at the images:

1. A dataset of different fruit images.
2. A machine sorting fruits into categories.

What role does machine learning play here?

- (a) The system learns patterns from training data and sorts fruits accordingly.
- (b) The machine memorizes all possible fruit shapes without learning.
- (c) Sorting does not require machine learning.
- (d) The system only works if humans manually classify each fruit in real-time.

**Ans :**

(a) The system learns patterns from training data and sorts fruits accordingly.

Machine learning models analyze features of labeled data (e.g., shape, color) and classify new inputs based on learned patterns, enabling automated fruit sorting.

## TWO MARKS QUESTIONS

- 75.** Differentiate between automated and autonomous systems.

**Ans :**

MAIN 2024

Automated systems follow fixed, predefined rules with no adaptation. Autonomous systems can learn or adapt in changing or uncertain environments.

- 76.** What is a deterministic process? Give one example.

**Ans :**

SQP 2025

A deterministic process always yields the same result for a given input, like a calculator performing  $2 + 2 = 4$ .

- 77.** Why is human decision making considered subjective?

**Ans :**

COMP 2014

Humans often use personal experience, biases, and emotions, which can vary from one person or situation to another, making decisions subjective.

- 78.** State one difference between machine decision making and human decision making.

**Ans :**

MAIN 2007

Machine decisions rely on algorithms and data,

whereas humans use intuition, emotional context, and experience.

- 79.** What is “training data” in machine learning?

**Ans :**

SQP 2017

It is the labeled dataset from which an algorithm learns patterns, adjusting its internal parameters to improve prediction or classification.

- 80.** Define “probabilistic” in the context of autonomous systems.

**Ans :**

COMP 2010

“Probabilistic” indicates the system handles uncertainty by estimating likelihoods or probabilities of different outcomes rather than producing a single guaranteed result.

- 81.** Give an example of a task where a machine could outperform human decision making.

**Ans :**

MAIN 2008

Sorting thousands of fruits quickly by color or shape is often more consistent and faster with a trained ML model than manual human sorting.

- 82.** Why might an automated system fail in unexpected conditions?

**Ans :**

SQP 2022

Because it cannot adapt beyond its programmed logic, unexpected situations not coded for may cause errors or a system crash.

- 83.** List any two steps in a machine learning workflow.

**Ans :**

COMP 2024

Data collection and preprocessing, followed by training a model and testing its performance on new data.

- 84.** How do humans typically classify objects?

**Ans :**

MAIN 2006

By using context, intuition, and personal experience—sometimes instantly recognizing patterns without explicit formulas.

- 85.** Give one advantage of using ML for fruit sorting over a manual threshold-based system.

**Ans :**

SQP 2012

ML can adapt to subtle variations (e.g., slightly different colors or shapes) and improve accuracy with more data, whereas thresholds remain static.

- 86.** Mention one characteristic of a purely automated process.

**Ans :** COMP 2018

It repeats the same actions based on fixed instructions or schedules, without learning from new scenarios.

- 87.** Why is large, high-quality data important in machine learning?

**Ans :** MAIN 2011

Models learn patterns from examples. If data is biased or insufficient, the resulting model will likely be inaccurate.

- 88.** What role do algorithms play in teaching machines to make decisions?

**Ans :** SQP 2010

Algorithms define how data is processed, how patterns are recognized, and how outputs are generated, acting as the “rules” for learning and decision-making.

- 89.** How can human bias differ from machine bias in decision making?

**Ans :** COMP 2008

Human bias arises from individual experiences or emotions, whereas machine bias typically comes from skewed training data or flawed algorithm design.

- 90.** Give one example each of a deterministic system and a probabilistic system.

**Ans :** MAIN 2022

Deterministic: A vending machine that always dispenses an item after correct payment.  
Probabilistic: A weather forecast model predicting rainfall percentages.

- 91.** What does “objective” mean in machine decision making?

**Ans :** MAIN 2013

It means basing outcomes on quantifiable data and algorithmic logic rather than subjective feelings or personal judgment.

- 92.** Name one common algorithm used in machine learning classification.

**Ans :** SQP 2016

Examples include decision trees, logistic

regression, or neural networks.

- 93.** Explain why a purely automated production line might need reprogramming when a new product is introduced.

**Ans :** COMP 2015

Its logic is designed only for existing tasks, so changes (e.g., product shapes) require code or hardware adjustments to handle the new specifications.

- 94.** What is the significance of fruit sorting as an ML example?

**Ans :** MAIN 2019

It illustrates how machines learn to classify different categories (apples, bananas, etc.) using data on attributes like color or shape—demonstrating the fundamentals of supervised learning.

### THREE MARKS QUESTIONS

- 95.** Explain why autonomous systems often employ probabilistic models.

**Ans :** MAIN 2025

They must handle unpredictable or incomplete information (e.g., sensor noise, changing conditions). By assigning probabilities, they account for uncertainty and choose the most likely correct action. This allows them to adapt more effectively compared to rigid, deterministic logic.

- 96.** Differentiate human decision making and machine decision making with an example.

**Ans :** SQP 2009

Humans might categorize fruit by glancing at shape or color, sometimes using emotional or cultural context (“I prefer red apples”). A machine uses numeric features (color range, shape metrics) extracted from images, applying a learned model. This leads to an objective classification approach.

- 97.** Why is data preprocessing crucial in a machine learning pipeline?

**Ans :** COMP 2014

Raw data may contain missing values, outliers, or irrelevant features. Preprocessing cleans and

standardizes the dataset, ensuring the model sees consistent, reliable inputs. Without preprocessing, the model can become inaccurate or misled by random noise and anomalies.

- 98.** How does an automated washing machine differ from an autonomous robot vacuum?

**Ans :** MAIN 2007

The washing machine follows preset cycles (wash, rinse, spin) with minimal variation—it's automated. The autonomous vacuum scans rooms, avoids obstacles, and adapts its path to layout changes—making it more autonomous and probabilistic in navigation logic.

- 99.** Explain “overfitting” in the context of machine learning.

**Ans :** SQP 2017

Overfitting occurs when a model memorizes training data, capturing noise and random fluctuations rather than true patterns. Consequently, it performs excellently on the training set but poorly on new, unseen data. Proper regularization and balanced datasets help mitigate overfitting.

- 100.** Discuss how subjective biases can affect human classification tasks.

**Ans :** COMP 2025

People may unconsciously prefer certain shapes or colors, ignoring relevant details. Cultural, personal, or emotional factors can lead to inconsistent judgments. This subjectivity can vary widely between individuals, unlike a uniform algorithmic approach.

- 101.** Outline the general steps in training a machine learning model to classify images.

**Ans :** MAIN 2021

First, collect and label a dataset of images. Next, preprocess images (resizing, normalization). Then choose and train a classification algorithm (e.g., a CNN), adjusting parameters to minimize errors. Finally, evaluate on a separate test set to measure real-world accuracy.

- 102.** Why might an autonomous system outperform an automated system in a dynamic environment?

**Ans :** SQP 2023

Autonomous systems can adapt to surprises, using sensor data to recalculate actions. Automated

systems only handle known inputs. Thus, in unpredictable settings (e.g., navigating crowded spaces), autonomy is more effective and flexible.

- 103.** How does an ML-based fruit-sorting system handle variability in fruit appearances?

**Ans :** COMP 2024

By training on diverse examples (different sizes, colors, angles), the model learns generalized patterns. When new fruits appear, it identifies them based on these learned features rather than relying on a single threshold, thus tolerating normal variations.

- 104.** Explain why programming remains essential even for “subjective” tasks in machines.

**Ans :** MAIN 2013

Machines need algorithms to parse data and make decisions. To emulate subjective tasks, developers design programs that interpret patterns statistically. Thus, code is pivotal for setting how the machine learns and processes intangible or fuzzy concepts.

- 105.** Give an example of a scenario where deterministic logic is inadequate, but autonomy or ML can succeed.

**Ans :** SQP 2016

Self-driving in unpredictable traffic. Deterministic rules alone cannot account for unexpected maneuvers or road changes. ML-driven autonomy uses sensor input and learned strategies to respond to rapidly changing environments, improving safety and navigation.

- 106.** Contrast how humans and machines handle classification errors.

**Ans :** COMP 2015

Humans might overlook minor mistakes, adjusting intuitively next time. Machines correct errors by retraining with more data or adjusting algorithm parameters. Human revision is more intuitive, while machines rely on a formal feedback loop or updated training sets.

- 107.** Discuss why a well-labeled dataset is crucial in supervised machine learning.

**Ans :** MAIN 2019

Labels guide the model's understanding of correct vs. incorrect classifications. If labels are inconsistent or wrong, the model “learns”

flawed associations. Proper labeling ensures the algorithm's learning signals align with actual ground truth, boosting accuracy.

- 108.** Explain how a basic threshold-based fruit sorter might fail compared to an ML-based sorter.

**Ans :** SQP 2006

A threshold-based sorter splits fruit by a single rule (e.g., color intensity), missing subtle variations in shape, texture, or multi-hued fruits. An ML-based approach sees many features, learning robust patterns and thus adapting better to real-world inconsistencies.

- 109.** In what ways can humans still be superior at decision making compared to machines?

**Ans :** COMP 2012

Humans excel where deep context, emotional intelligence, or creative reasoning is vital. Complex social or ethical judgments often surpass machine logic. While algorithms handle large data quickly, they lack genuine insight or moral frameworks that humans can apply.

- 110.** Describe a simple application of probabilistic decision making in daily life.

**Ans :** MAIN 2018

Weather apps forecast rain probability (e.g., 70% chance of rain). Users make decisions (carry an umbrella) based on these likelihoods, acknowledging the forecast isn't 100% certain but helpful in handling uncertainty.

- 111.** Why might a system using rules from 10 years ago be insufficient for today's environment?

**Ans :** SQP 2011

Conditions change—technology evolves, user needs shift, data patterns differ. A static rule-based system becomes outdated, failing to handle modern contexts. Systems that learn or update are better suited to keep pace.

- 112.** Explain the term “generalization” in machine learning.

**Ans :** COMP 2009

Generalization is a model's ability to apply learned patterns to new, unseen data effectively. If a model memorizes specifics of the training set without broader insight, it struggles to classify fresh examples, signifying poor generalization.

- 113.** Discuss one challenge of implementing an autonomous robot in a busy factory environment.

**Ans :** MAIN 2014

The robot must detect and adapt to obstacles, dynamic workflows, and human co-workers. Achieving safe interactions requires robust sensor fusion, real-time processing, and advanced algorithms. Reliability and avoiding collisions are critical concerns.

- 114.** How can data bias lead to flawed machine decisions?

**Ans :** SQP 2007

If the training data misrepresents reality (e.g., insufficient examples of certain categories), the model skews its classifications. It may consistently mislabel or underperform on underrepresented groups. This data-driven bias can perpetuate unfair outcomes or inaccuracies.

## CASE BASED QUESTION

- 115.** A factory invests in a fruit-sorting line. Initially, they set color thresholds for red apples, but these miss certain partially red varieties. Propose an ML-based solution.

**Ans :**

1. Data Collection: Gather images of apples in various color shades.
2. Model Choice: Train a classifier on these images, labeling each “apple” vs. other fruits.
3. Implementation: Replace the fixed threshold with the ML model's predictions. This allows partial red apples to be recognized if enough “apple features” match the learned patterns.

- 116.** A small business uses an automated system to fill bottles but wants it to adapt if bottles come in new sizes unexpectedly. Why is an autonomous approach more suitable?

**Ans :**

1. Automated Limitation: The current system likely uses fixed volume/timing for the standard bottle.
2. Autonomy: A sensor-based feedback loop can detect new bottle dimensions and adjust fill levels.

3. Benefits: Fewer stoppages, less reprogramming, and better handling of product variations.

**117.** A group of students tries to replicate human classification of emojis via ML. Outline key steps.

**Ans :**

1. Collect Data: Thousands of emoji images, each labeled by category (happy, sad, etc.).
2. Preprocess: Resize images, standardize color channels.
3. Train: Feed into an ML classifier (e.g., a neural network).
4. Evaluate: Measure accuracy on new emoji sets.
5. Refine: Adjust model if misclassifications persist.

**118.** A deterministic traffic light system is replaced with an adaptive one that changes signals based on real-time traffic flow. Discuss the difference in approach.

**Ans :**

1. Deterministic: Fixed timers control lights, ignoring current vehicle buildup or road conditions.
2. Adaptive: Uses sensors to measure congestion, adjusting signals dynamically.
3. Outcomes: Reduced wait times, better traffic throughput, albeit requiring more complex software and sensor data processing.

**119.** A bakery's dough kneading machine uses fixed settings. Occasionally, dough consistency changes with humidity. Suggest an autonomous modification.

**Ans :**

1. Problem: A single cycle cannot adapt if the dough is too dry or wet.
2. Autonomous Upgrade: Add sensors measuring dough resistance or moisture.
3. Control Logic: A small ML model or rule-based feedback adjusts kneading time or water addition, ensuring consistent dough quality despite humidity changes.

**120.** An online store classifies fruit images uploaded by farmers. They want to shift from manual labeling to an ML classifier. Summarize the approach.

**Ans :**

1. Dataset: Compile labeled fruit images from previous manual processes.

2. ML Model: Train on these labeled examples.
3. Deployment: New images run through the classifier. If uncertain, partial human review can refine the model's predictions. Over time, it becomes more accurate, reducing manual labor.

**121.** In a production line, an automated robot places caps on bottles. Bottles frequently shift position. The robot fails to place caps correctly. Why might a vision-based autonomous solution help?

**Ans :**

1. Automated Limitations: The robot likely expects the bottle at a precise location.
2. Vision Integration: A camera can locate bottle tops in real time, adjusting the robot's arm position.
3. Autonomy: Adapts to slight shifts or orientation changes, preventing misalignment errors.

**122.** A school project aims to show how humans classify shapes subjectively while a computer uses an algorithm. Suggest a demonstration setup.

**Ans :**

1. Human Task: Show students random shapes, ask them to label them quickly ("circle," "square," "rectangle"), noticing personal biases or misjudgments.
2. Machine Task: A small ML classifier trained on shape features.
3. Comparison: The project reveals where humans may guess or use partial context, while the machine systematically uses numeric features.

**123.** A fruit distributor wants to incorporate ripeness checks into their automated line. The line can only measure color right now. Propose an ML-based enhancement.

**Ans :**

1. Additional Data: Include color shading, texture, softness (maybe via force sensors).
2. ML Model: Train on labeled examples of "ripe," "unripe," "overripe."
3. Outcome: The model uses combined sensors to classify ripeness levels, going beyond simple color thresholds.

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- 124.** A museum organizes paintings by style. Humans subjectively tag them, but they want a consistent machine-based approach for new artwork. Outline the ML steps.

**Ans :**

1. **Data & Labels:** Compile a database of artworks with style labels (e.g., Impressionist, Cubist).
2. **Feature Extraction:** Possibly color distribution, brushstroke patterns, shapes.
3. **Algorithm:** A classification model trained to categorize painting styles.
4. **Deployment:** The system suggests styles for new artworks, ensuring consistent classification.

- 125.** A home appliance company wants to design a washing machine that operates through fixed cycles. Should they implement an automated system or an autonomous system, and why?

**Ans :**

They should implement an automated system because it follows predetermined, fixed rules (deterministic behavior) that ensure the same cycle is executed every time.

This predictability is ideal for appliances where consistent, unvarying performance is critical.

- 126.** A self-driving car must navigate through changing traffic conditions using sensor inputs and real-time data. Should this system be considered automated or autonomous, and why?

**Ans :**

It should be considered an autonomous system because it adapts to uncertain, dynamic environments using probabilistic decision-making. This adaptability enables the car to handle unexpected events and varying conditions effectively.

- 127.** In a factory setting, a robotic arm consistently performs the same assembly task without deviation. Is this system deterministic or probabilistic, and what is the significance of that classification?

**Ans :**

This system is deterministic since the same input always results in the same output.

Deterministic systems are highly reliable in controlled environments where repeatability is essential.

- 128.** A drone must adjust its flight path when encountering sudden wind gusts. Which type of system behavior does this represent, and why?

**Ans :**

It represents probabilistic behavior because the drone must adapt its actions based on real-time sensor feedback from an unpredictable environment.

Probabilistic systems use data-driven adjustments to maintain stability in dynamic conditions.

- 129.** Compare human and machine decision-making by providing one advantage for each. How do these differences support potential collaboration between humans and machines?

**Ans :**

Humans excel in handling abstract concepts, intuition, and context, while machines provide objective, consistent, and data-driven decisions.

This complementary relationship enables systems where machines process large data sets and humans oversee ethical, contextual, and creative decisions.

- 130.** When classifying objects, humans quickly recognize items based on context and prior experience. How do machines perform object classification, and what is one potential drawback?

**Ans :**

Machines classify objects by analyzing features such as color, size, and shape, often using machine learning algorithms to recognize patterns.

However, if the data is incomplete or ambiguous, machines may misclassify objects since they lack the intuitive context that humans naturally use.

- 131.** Outline the key steps involved in developing a machine learning model for a classification task such as sorting fruits.

**Ans :**

The steps include:

1. **Data Collection:** Gather images or attributes of fruits.
2. **Data Preprocessing:** Clean and label the data.
3. **Algorithm Selection/Design:** Choose a classifier (e.g., a neural network).
4. **Training:** Allow the algorithm to learn from labeled examples.
5. **Validation & Testing:** Evaluate performance on unseen data.

6. Deployment: Implement the model in the sorting system.

Following these structured steps ensures that the model learns effectively and performs reliably in real-world conditions.

- 132.** Why is programming fundamental in machine learning, particularly when it comes to instructing computers to process data and train models?

**Ans :**

Programming provides the framework for writing algorithms that process data, train models, and make predictions.

Without robust programming, it would be impossible to implement the complex mathematical models that drive machine learning systems.

- 133.** In the fruit sorting example, what is the role of training within the machine learning process, and why is it critical for the system's performance?

**Ans :**

Training involves feeding the algorithm with labeled examples (e.g., images of apples, bananas, and oranges) so it can learn distinguishing features and classify new fruits accurately.

The quality and quantity of training data directly affect the model's accuracy and its ability to generalize to unseen examples.

- 134.** Describe a scenario in a smart manufacturing plant where integrating deterministic (automated) systems with autonomous systems could be beneficial.

**Ans :**

In a smart manufacturing plant, a deterministic robotic arm can perform repetitive assembly tasks reliably, while an autonomous system monitors product quality and adjusts operations based on real-time sensor data.

Combining these systems leverages the reliability of automation for routine tasks with the flexibility of autonomous systems to manage unexpected variations and optimize overall production efficiency.

- (a) Physical gestures from the machine
- (b) Text-based conversation between a judge and an unseen interlocutor
- (c) Audio-based emotional responses
- (d) Robotic movement demonstrations

Ans :

COMP 2008

- (b) Text-based conversation between a judge and an unseen interlocutor

The Turing Test's original format involves text-only communication to prevent visual or auditory giveaways. The judge interacts via written questions and answers. Physical gestures or audible responses were excluded to focus purely on conversational intelligence.

19. An example of "false claims for computers" could be \_\_\_\_\_.
- (a) Stating a system is 100% hack-proof
  - (b) Warning of possible data breaches
  - (c) Presenting realistic performance metrics
  - (d) Giving disclaimers about limitations

Ans :

MAIN 2010

- (a) Stating a system is 100% hack-proof
- Claiming absolute security or performance is misleading, as no system can be totally immune to hacks. This is considered making an unrealistic promise or overstating capability. Realistic disclosures and disclaimers reflect actual system constraints.

20. Which statement aligns with Alan Turing's perspective on machine intelligence?
- (a) If a machine can convincingly mimic human responses, it shows intelligence
  - (b) Machines must prove consciousness first
  - (c) Only numerical computation matters
  - (d) Humans will never be fooled by a machine

Ans :

SQP 2025

- (a) If a machine can convincingly mimic human responses, it shows intelligence
- Turing argued that if a computer's conversation is indistinguishable from a human's, we can say it demonstrates intelligent behavior. He didn't assert that consciousness or purely numeric computation was the main factor, nor did he claim humans would never be deceived.

21. Using a computer to commit fraud might include \_\_\_\_\_.
- (a) Phishing or scam emails to trick victims
  - (b) Updating an antivirus license
  - (c) Donating software to an open-source project

- (d) Changing your own password frequently

Ans :

COMP 2021

- (a) Phishing or scam emails to trick victims
- Fraud includes deceiving people for financial or personal gain, often via phishing emails or malicious links. Installing or donating software is legitimate usage, and regularly updating passwords is good security practice.

22. The Turing Test does NOT directly assess \_\_\_\_\_.

- (a) How well a machine can keep a conversation
- (b) A machine's ability to mimic human writing style
- (c) A machine's internal consciousness or self-awareness
- (d) Whether a judge is confused by the machine's responses

Ans :

MAIN 2023

- (c) A machine's internal consciousness or self-awareness

The Turing Test looks at outward behavior—textual replies—and sees if they mimic a human. It doesn't measure or prove genuine consciousness. "Passing" only shows successful imitation, not self-awareness or true sentience.

23. What is a typical consequence of software piracy for developers?
- (a) Increased revenue
  - (b) Financial loss and reduced incentive to innovate
  - (c) Guaranteed product improvements
  - (d) Complete safety from hacking

Ans :

SQP 2024

- (b) Financial loss and reduced incentive to innovate
- Piracy deprives software creators of rightful earnings, reducing potential funds for development or support. This lowers incentives to produce quality products. Although some argue broader distribution, on the whole, unlicensed use impacts developers' revenue and sustainability.

24. Which of the following best explains why hacking is ethically problematic?
- (a) It uses no external tools
  - (b) It respects individual privacy
  - (c) It can harm individuals or organizations by stealing or damaging data
  - (d) Hackers always obtain permission first

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### 4.3 Common Cyber Threats and Countermeasures

1. Threats : Malware (viruses, ransomware), phishing, denial of service attacks, insider threats.
2. Countermeasures : Antivirus software, firewalls, strong passwords, encryption, security awareness training.

## MULTIPLE CHOICE QUESTION

1. Which best describes the purpose of the Turing Test?
  - (a) To measure a machine's raw computing power
  - (b) To test if a machine can learn from labeled data
  - (c) To determine if a machine's responses are indistinguishable from a human's
  - (d) To check whether a machine has physical sensors

Ans :

MAIN 2024

(c) To determine if a machine's responses are indistinguishable from a human's  
 Alan Turing's test gauges whether a computer can mimic human conversational behavior well enough to fool a human judge. It does not measure learning ability per se or sensor usage. Instead, it focuses on whether the machine's text-based responses appear convincingly human.

2. Human intelligence differs from machine intelligence because \_\_\_\_\_.
  - (a) Humans never make errors
  - (b) Machines rely on emotions for decisions
  - (c) Humans can bring emotional and contextual judgment to decisions
  - (d) Machines do not process data

Ans :

SQP 2023

(c) Humans can bring emotional and contextual judgment to decisions  
 People often use emotion, personal context, and intuition in decision-making. Machines, by contrast, rely on programmed or learned algorithms that lack genuine emotional context. While humans do make errors, machine approaches to problems are generally objective, data-driven, and lack personal experience or emotion.

3. Which of the following is considered a classic challenge for AI regarding the Turing Test?

- (a) Numerical arithmetic
- (b) Complex AI tasks done in secret
- (c) Passing an unstructured text conversation undetected
- (d) Reciting a fixed set of answers

Ans :

COMP 2021

(c) Passing an unstructured text conversation undetected

The Turing Test specifically measures whether a computer can maintain a free-form conversation that is convincing enough to appear human. Simple arithmetic or fixed responses don't test the adaptability required for open-ended dialogues. Hence, true challenge is engaging unpredictably with a human judge.

4. Which scenario describes an unauthorized use of hardware?
  - (a) A user logging in with correct credentials
  - (b) A visitor deliberately using your laptop without permission
  - (c) Installing antivirus on your own PC
  - (d) Backing up data onto a personal drive

Ans :

MAIN 2025

(b) A visitor deliberately using your laptop without permission  
 Unauthorized use occurs when someone operates another's device (computer, laptop, phone) without explicit consent. Access must be granted by the owner. Installing antivirus on one's own PC or using correct credentials is typically authorized usage.

5. Software theft typically involves \_\_\_\_\_.
  - (a) Correctly purchasing a software license
  - (b) Running software on multiple machines under license
  - (c) Illegally copying, distributing, or using software without authorization
  - (d) Downloading open-source software

Ans :

SQP 2019

(c) Illegally copying, distributing, or using software without authorization  
 Software theft, also called piracy, is the illegal duplication, distribution, or usage of copyrighted software without adhering to licensing terms. Purchasing a license or using open-source software within its license terms is legal, whereas unauthorized copying violates intellectual property rights.

# CHAPTER 7

## MACHINE INTELLIGENCE AND CYBER SECURITY IN COMPUTING

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### 1. HUMAN VS. MACHINE INTELLIGENCE

1. Human Intelligence : Involves creativity, emotion, intuition, experience, and context-based reasoning.
2. Machine Intelligence : Algorithms and data-driven processes that enable computers to mimic certain human cognitive functions (e.g., problem-solving, learning).
3. Similarities : Both can perform tasks such as pattern recognition, decision making, and problem solving (within defined scopes).
4. Differences : Machines lack emotional awareness or genuine consciousness; they rely on programmed or learned instructions rather than innate understanding.

### 2. TURING TEST (BRIEF UNDERSTANDING)

1. Concept : Proposed by Alan Turing in 1950 to test a machine's ability to exhibit intelligent behavior indistinguishable from a human.
2. Setup : A human judge interacts with an unseen interlocutor (could be human or machine) through text-based conversation.
3. Passing the Test : If the judge cannot reliably distinguish the machine from a human, the machine is said to have passed the Turing Test.
4. Role in AI : While not a perfect measure of true intelligence, it remains a historical benchmark sparking debate about consciousness, imitation, and intelligence in machines.

### 3. CONNECTIVITY BETWEEN HUMAN AND MACHINE INTELLIGENCE

1. Collaboration : Machines assist humans in complex tasks (e.g., data analysis, repetitive processes), while humans provide creativity and ethical judgments.
2. Augmentation : AI can enhance human decision-making by providing rapid data insights, but final interpretive or moral decisions often remain with humans.
3. Ethical and Philosophical Debates : As

machine intelligence grows, questions arise about machine autonomy, rights, and responsibilities.

### 4. CYBER SECURITY

#### 4.1 Basic Understanding of Security and Ethical Issues

1. Unauthorized Use of Hardware : Using another person's computer or device without permission.
2. Software Theft : Piracy or copying software illegally.
3. Disputed Rights to Products : Intellectual property conflicts, where ownership or usage rights are uncertain or violated.
4. Computers Used for Fraud : Scams, identity theft, phishing, or financial crimes facilitated by digital systems.
5. Hacking and Data Theft : Unauthorized access to systems to steal or compromise data.
6. Sabotage with Viruses : Creating and spreading malicious software to disrupt or damage systems.
7. Reliability of Output : Ensuring computer-generated results are accurate, free from tampering, and responsibly interpreted.
8. False Claims for Computers : Exaggerating a system's capabilities or making misleading statements about its performance.
9. Degradation of Work : Potential job displacement, skill erosion, or ethical dilemmas as tasks become automated.

#### 4.2 Responsibility and Ethics

1. User Responsibility : Keeping personal credentials secure, reporting anomalies, abiding by software licenses.
2. Organizational Responsibility : Implementing security measures, updating software, managing employee access, and protecting customer data.
3. Legal Framework : National and international laws address cybercrime, intellectual property, data protection, and hacking offenses.

- 12.** One key difference between a virus and a hacking attempt is that \_\_\_\_\_.  
 (a) A virus is a self-replicating program; hacking is unauthorized system intrusion  
 (b) A virus is always ethical while hacking is not  
 (c) Hacking cannot cause data theft  
 (d) A virus only affects hardware, not software

**Ans :**

COMP 2006

(a) A virus is a self-replicating program; hacking is unauthorized system intrusion

Viruses are malicious programs that copy themselves and infect systems. Hacking involves unauthorized entry or manipulation of a system by a person or group. While both can compromise data, viruses spread on their own, whereas hacking typically involves active, direct exploitation of vulnerabilities.

- 13.** Which of the following is a reason why the Turing Test might be criticized?  
 (a) It focuses too much on numeric calculations  
 (b) It can be passed by clever mimicry rather than “true understanding”  
 (c) It guarantees consciousness if passed  
 (d) It only measures a system’s sensor input

**Ans :**

MAIN 2017

(b) It can be passed by clever mimicry rather than “true understanding”

Critics argue that passing the Turing Test might only show a machine’s ability to imitate human conversation (e.g., via pattern-based approaches) rather than genuine comprehension or consciousness. Thus, it’s seen as an imitation game rather than definitive proof of thinking.

- 14.** Unauthorized use of hardware, theft of software, and data theft can collectively be described as \_\_\_\_\_.  
 (a) Legal frameworks  
 (b) Cybercrimes and ethical violations  
 (c) Security updates  
 (d) Data backups

**Ans :**

SQP 2007

(b) Cybercrimes and ethical violations

Unauthorized hardware usage, software piracy, and data theft all break legal and ethical standards. They compromise rightful ownership, violate user privacy, and can cause financial or reputational harm. They are collectively seen as cybercrimes or unethical practices.

- 15.** Which of the following best describes “machine intelligence”?

- (a) Emotional behavior displayed by a computer  
 (b) Data-driven or algorithmic processes that resemble human problem-solving  
 (c) Random guessing methods in software  
 (d) A device requiring no programming

**Ans :**

COMP 2014

(b) Data-driven or algorithmic processes that resemble human problem-solving

Machine intelligence typically refers to AI techniques enabling computers to solve problems, recognize patterns, or learn from data. It doesn’t involve genuine emotion or random guesses. Programming and algorithms underpin these intelligent capabilities.

- 16.** In cybersecurity, a “phenomenon of hacking” means \_\_\_\_\_.  
 (a) Authorized password resets  
 (b) Illegal or unauthorized intrusion into computer systems  
 (c) Backing up personal data  
 (d) Sharing legal software publicly

**Ans :**

MAIN 2009

(b) Illegal or unauthorized intrusion into computer systems

Hacking usually involves exploiting system vulnerabilities without permission to gain access or manipulate data. This is distinct from legitimate actions like changing your own password or sharing software under legal licenses.

- 17.** Why might “responsibility for reliability of output” be a cybersecurity issue?

- (a) It’s irrelevant to security concerns  
 (b) Outputs can be misleading if tampered with by unauthorized users  
 (c) Hackers cannot alter computer outputs  
 (d) Users have no stake in checking results

**Ans :**

SQP 2022

(b) Outputs can be misleading if tampered with by unauthorized users

If a system’s output is manipulated, people may make decisions based on falsified or corrupted information. Holding individuals or organizations accountable for ensuring correct results is essential. Hackers can alter data or system processes, making reliability a key security concern.

- 18.** The Turing Test primarily involves which interaction style?

Critics often question whether convincingly human-like responses equate to true comprehension or consciousness. Thus, the Turing Test fuels debates on whether mimicking intelligence is the same as possessing it, a philosophical tension not resolved by simply fooling a judge.

- 31.** At a research institute, experts evaluate performance on complex pattern recognition tasks using both human analysts and AI systems. Which characteristic best distinguishes human intelligence from machine intelligence?

- (a) Strict adherence to algorithms
- (b) Creativity and emotional intuition
- (c) Uniform decision making
- (d) Reliance solely on data processing

**Ans :**

MAIN 2011

- (b) Creativity and emotional intuition

Humans possess creativity, emotion, intuition, and context-based reasoning, which allow for abstract thinking and innovative problem solving. Machines, in contrast, operate through algorithms and data-driven processes lacking genuine consciousness. This fundamental difference enables humans to handle complex, ambiguous situations in ways that machines, despite pattern recognition, cannot truly emulate effectively.

- 32.** A graduate student participates in a Turing Test experiment where a judge converses via text with an unknown interlocutor.

What is the primary criterion for a machine to pass the Turing Test?

- (a) To solve mathematical problems
- (b) To exhibit intelligent behavior indistinguishable from a human
- (c) To replicate human emotions exactly
- (d) To outperform humans in chess

**Ans :**

SQP 2009

- (b) To exhibit intelligent behavior indistinguishable from a human

Passing the Turing Test requires a machine to engage in conversation such that a human judge cannot reliably differentiate it from a human interlocutor. This measure focuses on exhibiting intelligent behavior through natural language communication, rather than solving specific problems or replicating emotions, thereby establishing a benchmark for machine intelligence.

- 33.** In a corporate setting, a data analyst collaborates with an AI system to process large datasets.

What advantage does machine intelligence offer in augmenting human decision-making?

- (a) Replacing human creativity entirely
- (b) Providing rapid data insights
- (c) Ignoring human ethical judgments
- (d) Operating without any human input

**Ans :**

COMP 2014

- (b) Providing rapid data insights

Machine intelligence excels at processing vast datasets quickly and identifying patterns that may be overlooked by humans. By augmenting human decision-making, it provides rapid data insights, allowing experts to focus on creativity and ethical considerations. This collaborative approach enhances efficiency, combining computational power with human intuition for superior outcomes effectively.

- 34.** A small business suffers a data breach after unauthorized access compromises its sensitive information.

Which cybersecurity threat is exemplified in this scenario?

- (a) Phishing
- (b) Hacking and data theft
- (c) Denial of service attack
- (d) Software piracy

**Ans :**

MAIN 2007

- (b) Hacking and data theft

Unauthorized access leading to a data breach exemplifies hacking and data theft, where intruders compromise systems to steal sensitive information. This threat poses financial and reputational risks for businesses. Implementing strong cybersecurity measures, such as firewalls and encryption, is critical to prevent unauthorized breaches and protect valuable data assets effectively.

- 35.** A fruit processing plant employs an AI-based fruit sorter that classifies fruits using visual data from cameras.

What is the primary process that enables the system to sort fruits accurately?

- (a) Hard-coded rules
- (b) Machine learning from labeled data
- (c) Random selection
- (d) Manual calibration

**Ans :**

SQP 2017

- (b) Machine learning from labeled data

The fruit sorter employs machine learning by training on labeled fruit images. This process

**Ans :**

COMP 2013

(c) It can harm individuals or organizations by stealing or damaging data

Hacking often violates privacy, damages systems, and results in stolen data or financial harm. Ethical hacking involves permission, but typical hacking lacks consent, making it unethical and often illegal. Therefore, it can be highly detrimental to victims.

**25.** If a machine passes the Turing Test, it indicates \_\_\_\_\_.

- (a) The machine is conscious and self-aware
- (b) The machine can fool judges into thinking it's human in conversation
- (c) It solves complex math problems uniquely
- (d) It physically looks like a human

**Ans :**

MAIN 2016

(b) The machine can fool judges into thinking it's human in conversation

Passing the Turing Test means the machine's text responses were sufficiently human-like to deceive evaluators. It does not confirm consciousness, only that it can mimic human conversation effectively. Neither physical appearance nor advanced math necessarily matters for the test.

**26.** Data theft, fraud, hacking, and viruses are examples of \_\_\_\_\_.

- (a) Legally required processes
- (b) Cybersecurity threats and criminal activities
- (c) Positive uses of computer systems
- (d) Strictly hardware issues

**Ans :**

SQP 2015

(b) Cybersecurity threats and criminal activities  
These actions compromise security, cause financial damage, or violate privacy laws. They are regarded as cybercrimes. Proper cybersecurity measures aim to prevent or mitigate these threats, ensuring systems operate safely.

**27.** Why might machine intelligence be beneficial in cybersecurity?

- (a) Machines fail to detect patterns in large data
- (b) AI-based threat detection can quickly identify anomalies and attacks
- (c) It always introduces new vulnerabilities
- (d) It replaces the need for human oversight entirely

**Ans :**

COMP 2019

(b) AI-based threat detection can quickly identify anomalies and attacks

Machine learning can rapidly analyze massive network logs or user behavior for suspicious patterns, revealing potential hacks or anomalies. Such automated detection often surpasses manual checks in speed. However, it doesn't eliminate the need for human security experts.

**28.** A user claims their antivirus is "perfectly foolproof." This might be an example of \_\_\_\_\_.

- (a) Responsible advertising
- (b) True statement if the software is expensive
- (c) Making false or exaggerated claims for a computer product
- (d) A normal disclaimer

**Ans :**

MAIN 2006

(c) Making false or exaggerated claims for a computer product

No antivirus is entirely invulnerable or "foolproof" given the evolving nature of malware. Stating absolute perfection misleads users. Ethical marketing typically acknowledges limitations or possible threats that remain.

**29.** Which of the following is essential to prevent "degradation of work" due to automation?

- (a) Providing employee retraining and upskilling opportunities
- (b) Immediately banning all automation
- (c) Encouraging unauthorized hardware usage
- (d) Allowing any software piracy

**Ans :**

SQP 2012

(a) Providing employee retraining and upskilling opportunities

As automation can displace certain jobs or reduce the need for manual labor, retraining or upskilling helps workers transition to roles requiring higher-level skills. Banning automation is impractical, and encouraging illegal or unethical practices is not a solution.

**30.** What is a key philosophical question raised by the Turing Test?

- (a) Does passing the test prove genuine understanding or just imitation?
- (b) Is a machine required to have physical hands?
- (c) Do computers need hacking features?
- (d) Can a system always produce accurate numeric results?

**Ans :**

COMP 2018

(a) Does passing the test prove genuine understanding or just imitation?

6. What is meant by “data theft”?
- Legally accessing a shared drive
  - Unauthorized copying or transferring of information
  - Deleting one’s own files
  - Regular system backups

Ans :

COMP 2015

(b) Unauthorized copying or transferring of information

Data theft involves illicitly obtaining confidential or personal data without permission. Examples include hacking into a database or copying company secrets. Legitimate activities like backing up personal files or accessing shared drives with permission do not constitute theft.

7. In the context of the Turing Test, a system is said to exhibit intelligence if \_\_\_\_\_.
- It wins at chess by brute force
  - It convinces a human judge that it’s also human in a conversation
  - It calculates sums faster than a human
  - It has physical sensors like cameras

Ans :

MAIN 2016

(b) It convinces a human judge that it’s also human in a conversation

The Turing Test involves text-based exchanges, with the human judge unaware of the interlocutor’s identity. If the judge cannot distinguish the machine from a human, the machine “passes.” Merely performing brute force calculations or using sensors doesn’t suffice to pass this test of conversational intelligence.

8. Disputed rights to products in technology usually concern \_\_\_\_\_.
- Only hardware malfunctions
  - Intellectual property ownership and usage rights
  - Physical damage to a PC
  - Replacing batteries

Ans :

SQP 2013

(b) Intellectual property ownership and usage rights

Disputed rights typically refer to who owns inventions, software code, or creative digital outputs. Examples include patent or copyright conflicts. Physical hardware damage or battery replacement is less about product rights and more about maintenance or repair issues.

9. Hacking and sabotage with viruses are examples of \_\_\_\_\_.

- Harmless computer pranks
- Legal data recovery methods
- Cybercriminal activities that compromise data or systems
- Ethical hacking for system improvement

Ans :

COMP 2011

(c) Cybercriminal activities that compromise data or systems

Illegally accessing systems (hacking) or unleashing malware (like viruses) to damage, steal data, or sabotage operations is considered cybercrime. Ethical hacking involves permissioned security testing, so typical hacking and virus sabotage are illicit and malicious activities.

10. “Making false claims for computers” could involve which scenario?
- Claiming a system can solve all problems instantly
  - Stating realistic limitations of hardware
  - Warning users about possible data loss
  - Installing security patches

Ans :

MAIN 2018

(a) Claiming a system can solve all problems instantly

Overstating a computer’s capabilities—for example, implying it has human-like consciousness or can handle tasks it cannot—is considered making false claims. Legitimately explaining limitations or applying security updates is reasonable, not misleading.

11. The Turing Test is historically significant because \_\_\_\_\_.
- It solves all ethical questions about AI
  - It provides a definitive measure of consciousness
  - It sparked debate on whether machines can appear “intelligent”
  - It is a mandatory exam for all AI systems

Ans :

SQP 2012

(c) It sparked debate on whether machines can appear “intelligent”

Alan Turing’s concept was groundbreaking in framing how we evaluate machine behavior relative to human intelligence. Although imperfect, it shaped discussions and further research on AI. It neither addresses consciousness definitively nor is it mandatory for every AI system.

enables the system to learn distinctive features such as color, size, and shape. As more data is processed, the model's classification accuracy improves, resulting in precise and efficient sorting of fruits during production operations very reliably.

- 36.** At a tech conference panel, experts discuss decision-making differences between humans and machines.

Which statement best summarizes a key difference between human and machine intelligence?

- (a) Humans lack emotional awareness
- (b) Machines operate solely on algorithms and data
- (c) Machines can intuitively understand context
- (d) Humans rely exclusively on programmed instructions

**Ans :**

COMP 2010

- (b) Machines operate solely on algorithms and data

The key difference lies in the fact that machines operate solely on algorithms and data, lacking genuine emotions, intuition, or consciousness. In contrast, human intelligence incorporates creativity, emotional awareness, and contextual reasoning. This fundamental distinction influences decision-making processes, as humans bring subjective judgment while machines follow objective, data-driven procedures effectively.

- 37.** An employee inadvertently downloads unlicensed software and shares it company-wide, triggering legal concerns.

Which cybersecurity ethical issue does this scenario illustrate?

- (a) Unauthorized use of hardware
- (b) Software theft and piracy
- (c) Hacking and data theft
- (d) Sabotage with viruses

**Ans :**

MAIN 2008

- (b) Software theft and piracy

The scenario highlights the ethical issue of software theft and piracy, where unlicensed software is illegally shared and used without proper authorization. This practice violates intellectual property rights, resulting in legal consequences and losses. Adhering to ethical standards and legal frameworks is essential to maintain trust and protect digital assets.

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- 38.** A financial institution experiences an incident where malicious software encrypts its systems and demands a ransom.

Which cybersecurity threat is demonstrated in this incident?

- (a) Denial of service attack
- (b) Phishing
- (c) Ransomware attack
- (d) Insider threat

**Ans :**

SQP 2022

- (c) Ransomware attack

This incident exemplifies a ransomware attack, where malicious software encrypts critical system data and demands a ransom for its release. Such attacks disrupt operations and can lead to major losses. Robust cybersecurity measures, including regular backups and antivirus software, are vital to detect and mitigate ransomware threats, protecting organizational data.

- 39.** A multinational corporation implements strict policies and security protocols to safeguard customer data.

What organizational responsibility is emphasized in this scenario?

- (a) Unauthorized use of hardware
- (b) Implementing robust cybersecurity measures
- (c) Software piracy prevention
- (d) Disregarding data protection laws

**Ans :**

COMP 2025

- (b) Implementing robust cybersecurity measures

In this scenario, the corporation prioritizes organizational responsibility by implementing robust cybersecurity measures. Such policies involve updating software, managing access, and protecting customer data. These practices ensure that sensitive information is safeguarded against breaches, maintaining trust and complying with legal frameworks, thereby reducing risks associated with cyber threats effectively, consistently.

- 40.** A hospital deploys an advanced diagnostic system that analyzes patient data and suggests possible diagnoses to doctors.

How does this system illustrate the connectivity between human and machine intelligence?

- (a) It replaces doctors entirely.
- (b) It augments human decision-making with rapid data insights.
- (c) It functions without any human input.
- (d) It solely relies on predetermined rules.

**Ans :**

MAIN 2021

(b) It augments human decision-making with rapid data insights.

The diagnostic system exemplifies connectivity between human and machine intelligence by combining rapid data analysis with human expertise. While the AI processes large datasets to identify patterns, doctors use experience and ethical judgment to interpret results. This synergy enhances diagnostic accuracy and patient outcomes, ensuring technology supports human decision-making efficiently.

**41.** Which statement about the Turing Test is correct?

- (a) It measures a machine's consciousness definitively
- (b) It checks if a machine fools judges into believing it's human through conversation
- (c) It focuses on a robot's physical movements
- (d) It is a mandatory international AI standard

**Ans :**

SQP 2023

(b) It checks if a machine fools judges into believing it's human through conversation

The Turing Test uses conversation to see if a computer can appear human. It doesn't measure consciousness, nor is it globally mandated. Physical robotics isn't part of the original setup. Mimicking human conversation is the core criterion.

**42.** Which statement correctly describes a machine's passing of the Turing Test?

- (a) It proves the machine is sentient
- (b) It shows the machine can replicate human text-based conversation indistinguishably
- (c) It involves no need for language understanding
- (d) It focuses only on numeric calculation

**Ans :**

COMP 2024

(b) It shows the machine can replicate human text-based conversation indistinguishably

Passing indicates that, through text interaction, human judges cannot distinguish it from a human. This does not confirm consciousness. The test heavily involves language, not mere arithmetic. Hence, (b) is the correct statement.

**43.** Which statement about cybersecurity is correct?

- (a) Unauthorized hardware use, hacking, and data theft are considered normal usage
- (b) Hacking is always legal if the hacker gains knowledge
- (c) Installing malware is a recommended practice for system testing

(d) Malware, data theft, and fraud are illegal or unethical acts harming security

**Ans :**

MAIN 2013

(d) Malware, data theft, and fraud are illegal or unethical acts harming security

Malware deployment, hacking for theft, or unauthorized intrusions are illegal, unethical, and threaten cybersecurity. They compromise data, disrupt services, and violate privacy or property rights. The other options are incorrect or condone illegal acts.

**44.** Which is the correct statement regarding human vs. machine intelligence?

- (a) Humans rely on context and emotion; machines rely on algorithms and data
- (b) Humans have no intuition; machines do
- (c) Machines must have emotions to function
- (d) Humans process data only algorithmically

**Ans :**

SQP 2016

(a) Humans rely on context and emotion; machines rely on algorithms and data

Humans often incorporate contextual awareness, subjective feeling, or intuition. Machines operate under programmed instructions or learned patterns, typically ignoring emotional or contextual nuance unless explicitly modeled. Thus, (a) accurately contrasts them.

**45.** Which statement about software theft is correct?

- (a) It is legal if no profit is made
- (b) It's an ethical practice to copy software without permission
- (c) It violates intellectual property rights, causing financial loss to developers
- (d) It encourages developers to innovate

**Ans :**

COMP 2015

(c) It violates intellectual property rights, causing financial loss to developers

Copying or distributing software without authorization infringes on the creator's rights and can lead to revenue loss. Profit or not, it remains illegal. This discourages innovation rather than encouraging it.

**46.** Which statement correctly describes hacking?

- (a) Authorized intrusion for security improvements
- (b) Unauthorized access or manipulation of computer systems
- (c) Permanent hardware modification
- (d) Sending polite emails to request data

Ans :

MAIN 2019

(b) Unauthorized access or manipulation of computer systems

Without permission, hacking is illegal manipulation or accessing of a system. “Ethical hacking” requires consent. Genuine hacking is distinct from hardware modifications or legitimate data requests. Hence, (b) accurately captures hacking as unauthorized access.

47. Which statement about machine intelligence and moral judgment is correct?

- (a) Machines inherently understand ethics and morality
- (b) Machines rely on human programmers to encode ethical frameworks
- (c) Machines develop emotions over time
- (d) Humans have no role in machine ethics

Ans :

SQP 2006

(b) Machines rely on human programmers to encode ethical frameworks

Computers do not spontaneously develop moral or ethical reasoning. If any ethical logic is involved, it's programmed or learned through data. Ultimately, humans remain responsible for setting moral guidelines or designing fair algorithms.

48. Which statement best defines “making false claims for computers”?

- (a) Transparent advertising about limitations
- (b) Stating unrealistic guarantees about performance or safety
- (c) Providing accurate performance benchmarks
- (d) Acknowledging possible vulnerabilities

Ans :

COMP 2012

(b) Stating unrealistic guarantees about performance or safety

Exaggerating or misleading about a computer's capabilities—like claiming “100% foolproof security”—qualifies as a false claim. Transparent marketing includes disclaimers and realistic metrics, so (b) correctly identifies the notion of making unsubstantiated promises.

49. Which statement correctly explains responsibility for output reliability?

- (a) Users and organizations must ensure outputs aren't tampered with and are interpreted accurately
- (b) Any incorrect output is always legal
- (c) No accountability is needed for misleading results

(d) Hackers can correct false data

Ans :

MAIN 2007

(a) Users and organizations must ensure outputs aren't tampered with and are interpreted accurately

Both end users and system owners share responsibility to verify the integrity and reliability of computer outputs. This includes verifying that data wasn't maliciously altered and that results are used responsibly. The other statements are incorrect or trivialize accountability.

50. Which statement about the Turing Test and machine consciousness is correct?

- (a) Passing the Turing Test proves a machine is conscious
- (b) Turing Test only checks conversational indistinguishability, not actual awareness
- (c) Turing Test includes physical reflex tests
- (d) Consciousness and Turing Test are identical concepts

Ans :

SQP 2017

(b) Turing Test only checks conversational indistinguishability, not actual awareness

Turing's imitation game measures how human-like the machine's textual responses seem, ignoring deeper philosophical questions about self-awareness or consciousness. Hence, a system can pass without genuinely “feeling” anything. The test doesn't incorporate physical reflexes or definitive proof of consciousness.

## ASSERTION AND REASON

51. **Assertion (A)** : The Turing Test conclusively proves that a machine with human-like responses is self-aware.

**Reason (R)** : The Turing Test only measures how closely a system's responses resemble a human's conversation.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

**Ans :**

(c) I is true; II is false

The Turing Test indeed checks whether a computer can appear human in text dialogue. However, hacking typically requires permission to be legal (ethical hacking). Unapproved hacking is illegal. Hence, I is true, II is false.

**62. Statement :**

- I. Passing the Turing Test proves a machine is conscious.
- II. Passing the Turing Test indicates the machine can fool human judges through conversation.

**Options :**

- (a) Both I and II are true
- (b) Both I and II are false
- (c) I is true; II is false
- (d) I is false; II is true

**Ans :**

(d) I is false; II is true

Passing Turing's Test does not confirm consciousness, just the ability to mimic human dialogue. The second statement is accurate. Therefore, I is false; II is true.

**63. Statement :**

- I. Cybersecurity breaches include hacking and data theft.
- II. Cybersecurity breaches have no impact on organizations.

**Options :**

- (a) Both I and II are true
- (b) I is true; II is false
- (c) I is false; II is true
- (d) Both I and II are false

**Ans :**

(b) I is true; II is false

Hacking and data theft are major forms of cybersecurity breaches. They often cause serious damage—financial loss, legal problems, reputational harm. Thus, they significantly impact organizations, making statement II false, while I is true.

**64. Statement :**

- I. Unauthorized use of hardware is legal if the computer is left unlocked.
- II. Stealing a password is still unethical and potentially illegal, even if the user wrote it down publicly.

**Options :**

- (a) Both I and II are true

(b) I is true; II is false

(c) I is false; II is true

(d) Both I and II are false

**Ans :**

(c) I is false; II is true

Even if a device is left unlocked, operating it without permission remains unauthorized usage. Therefore, the first statement is false. The second is correct : using or stealing someone's password, even if discovered by carelessness, is unethical and possibly illegal.

**65. Statement :**

- I. A virus is a malicious software program designed to replicate.
- II. Data theft is typically a harmless act with no consequences.

**Options :**

- (a) Both I and II are true
- (b) I is false; II is true
- (c) I is true; II is false
- (d) Both I and II are false

**Ans :**

(c) I is true; II is false

Viruses replicate and harm systems, so statement I is correct. Data theft is not harmless; it has significant legal and ethical consequences. Hence, II is false.

**66. Statement :**

- I. Humans sometimes make decisions based on emotional context.
- II. Machines lack emotional awareness and rely on data-driven algorithms.

**Options :**

- (a) Both I and II are true
- (b) Both I and II are false
- (c) I is true; II is false
- (d) I is false; II is true

**Ans :**

(a) Both I and II are true

Human intelligence commonly involves emotion, while machines rely on logic or learned algorithms. Neither statement is incorrect—both reflect common, accepted distinctions between human and machine decision processes.

**67. Statement :**

- I. Making false claims for computers can mislead users about capabilities.
- II. This practice is ethically acceptable if it boosts sales.

The assertion is incorrect because hacking without explicit permission remains unethical, even if vulnerabilities exist. The reason is correct : ethical hacking requires authorized testing to identify weaknesses. Unapproved hacking is illegal. Thus, the assertion is wrong, reason is correct.

- 57. Assertion (A) :** Automated systems can adapt to unknown environments without reprogramming.

**Reason (R) :** Automated systems typically follow fixed rules and do not learn from data.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(c) Assertion is correct, but Reason is incorrect. The assertion is incorrect—most automated systems cannot adapt spontaneously. The reason is correct : they rely on predefined instructions, lacking a learning mechanism. Hence, (c) applies : The assertion is wrong, but the reason is correct.

- 58. Assertion (A) :** Machine intelligence can help detect suspicious patterns in network traffic for cybersecurity.

**Reason (R) :** Pattern recognition algorithms can analyze large volumes of data quickly, spotting anomalies humans might miss.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are true, and the reason explains how ML-based systems can monitor network logs at scale, identifying unusual activity. This directly supports the assertion that machine intelligence is beneficial for cybersecurity anomaly detection.

- 59. Assertion (A) :** “Degradation of work” implies that all jobs become obsolete immediately due to automation.

**Reason (R) :** Automation can shift or reduce

certain roles, requiring human workers to adapt or learn new skills.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct. The assertion is incorrect; not all jobs vanish instantly, though some tasks are displaced. The reason is correct in stating that automation changes job landscapes, prompting retraining rather than sudden universal obsolescence.

- 60. Assertion (A) :** Claiming a computer can never be hacked is considered a false claim.

**Reason (R) :** No system is 100% secure; new exploits and vulnerabilities appear regularly.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are correct, and the reason explains why absolute hack-proof claims are unrealistic : attackers continually develop new methods, and software inevitably has potential flaws. Thus, the reason justifies why such a claim is false.

## STATEMENT BASED QUESTIONS

- 61. Statement :**

- I. The Turing Test aims to evaluate a machine’s ability to replicate human-like conversation.
- II. Hacking is a fully legal approach to test security without permission.

**Options :**

- (a) Both I and II are true
- (b) Both I and II are false
- (c) I is true; II is false
- (d) I is false; II is true

- 107.** Why is software piracy considered detrimental to the tech industry?

**Ans :** SQP 2010

It deprives developers of revenue, curtailing updates, support, and innovation. If a company cannot recoup development costs due to widespread illicit copying, future software development may be scaled back or canceled, harming the broader ecosystem.

- 108.** How might data theft lead to identity fraud?

**Ans :** COMP 2008

Stolen personal information—like names, passwords, credit card details—lets criminals impersonate victims. They can conduct illegal transactions or open accounts under the victim's identity, leading to financial and reputational damage.

- 109.** Explain one method by which machine intelligence can improve Turing Test performance.

**Ans :** MAIN 2025

Models trained on vast conversational datasets can generate context-relevant, human-like responses. Techniques like natural language processing (NLP) and deep learning refine grammar and style, making machine outputs increasingly convincing to judges.

- 110.** Why might a purely automated system fail if product specifications change suddenly?

**Ans :** SQP 2009

It follows static rules designed for known conditions. Any unexpected variation (size, shape, or format) requires manual reprogramming. Without adaptive mechanisms, it cannot handle deviations spontaneously.

- 111.** Give an example of “phenomenon of hacking” in everyday life.

**Ans :** COMP 2021

A malicious actor gains unauthorized access to a neighbor's Wi-Fi, snooping on private browsing or capturing login credentials. This intrusion can compromise accounts and personal privacy.

- 112.** Discuss how “degradation of work” may manifest in an AI-driven factory.

**Ans :** MAIN 2010

As robots replace manual roles, workers might

lose skill sets or be laid off. Some employees might shift to maintenance or oversight roles, but many manual tasks vanish, leading to job displacement or diminished worker morale without retraining programs.

- 113.** Why is “making false claims for computers” especially harmful in cybersecurity contexts?

**Ans :** SQP 2023

Overstated security claims may lead users to neglect basic safeguards, believing the system is foolproof. Attackers exploit these gaps, causing severe data breaches or financial loss when the system fails to meet unrealistic assurances.

- 114.** What lesson about intelligence do we learn from comparing human and machine approaches, especially in Turing-like scenarios?

**Ans :** COMP 2008

Humans integrate context, emotion, and adaptability, while machines rely on structured learning or rules. Turing-like tests highlight that convincing imitation doesn't guarantee understanding, pushing us to consider deeper elements of cognition and ethics.

- 115.** Explain why continuous learning is essential in cybersecurity defense.

**Ans :** MAIN 2024

Threats evolve with new exploits daily, so static defenses quickly become outdated. Systems and professionals must regularly update knowledge, software, and strategies, employing AI to detect emerging patterns and vulnerabilities before major breaches occur.

## CASE BASED QUESTION

- 116.** A start-up claims their chatbot has passed the Turing Test. Potential customers wonder if it truly understands queries. Discuss how to evaluate their claim.

**Ans :**

1. Verification : Check test details—was it an official Turing-like setup with impartial judges?
2. Scope : Determine if the bot's responses are general or limited to a narrow domain.

**Options :**

- (a) Both I and II are true
- (b) I is true; II is false
- (c) I is false; II is true
- (d) Both I and II are false

**Ans :**

- (b) I is true; II is false

Overstating or lying about a system's capabilities indeed misleads consumers, which is unethical. The second statement claims it's acceptable for sales reasons, which is false ethically and often legally questionable. Thus, I is true, II is false.

**68. Statement :**

- I. Sabotage in the form of viruses can disrupt entire networks.
- II. Installing antivirus and updating software can mitigate virus threats.

**Options :**

- (a) Both I and II are true
- (b) Both I and II are false
- (c) I is false; II is true
- (d) I is true; II is false

**Ans :**

- (a) Both I and II are true

Viruses can spread rapidly across networked computers, causing system failures or data corruption. Meanwhile, proactive security measures—like antivirus software, firewalls, updates—help detect or prevent such threats. Both statements are therefore correct.

**69. Statement :**

- I. An automated software system with fixed rules can easily adapt to new scenarios.
- II. Autonomous systems often learn or adjust to changing inputs over time.

**Options :**

- (a) Both I and II are true
- (b) I is true; II is false
- (c) I is false; II is true
- (d) Both I and II are false

**Ans :**

- (c) I is false; II is true

Automated systems typically cannot change rules spontaneously, so they do not “easily adapt.” Autonomous systems, however, can incorporate machine learning or sensor feedback for dynamic adaptation. Hence, I is false, II is true.

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**70. Statement :**

- I. The Turing Test evaluates a machine's conversation abilities against a human baseline.
- II. Hacking is harmless if it doesn't cause data theft.

**Options :**

- (a) Both I and II are true
- (b) I is true; II is false
- (c) I is false; II is true
- (d) Both I and II are false

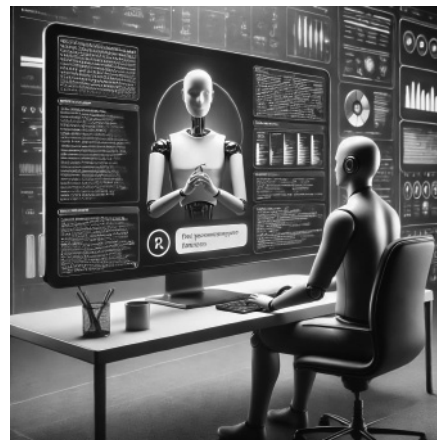
**Ans :**

- (b) I is true; II is false

The Turing Test focuses on conversational indistinguishability from a human, so I is true. Hacking, even without direct data theft, is still unauthorized system intrusion, making it unethical or illegal. So II is false.

## PICTURE BASED QUESTIONS

- 71.** Observe the image showing a human interacting with a computer through a text-based chat. The person cannot see who is responding. What is this test called?



- (a) CAPTCHA Test
- (b) Turing Test
- (c) IQ Test
- (d) Emotional Intelligence Test

**Ans :**

- (b) Turing Test

The Turing Test, proposed by Alan Turing in 1950, measures a machine's ability to exhibit human-like intelligence. If a human judge cannot

distinguish between responses from a human and a machine, the AI is said to have passed the test.

72. The image shows a machine playing chess against a human. The machine is analyzing multiple possible moves in seconds. What does this best illustrate?



- (a) Machines excel in logical problem-solving based on algorithms.
- (b) Machines can think like humans.
- (c) Machines have emotions and intuition.
- (d) Machines make decisions based on feelings.

Ans :

- (a) Machines excel in logical problem-solving based on algorithms.

Machines use predefined algorithms and data-driven decision-making to analyze multiple possibilities in a structured environment, such as chess. However, they lack emotions, creativity, and intuition, which are key aspects of human intelligence.

73. The image depicts an individual receiving an email that claims they have won a large sum of money and requests bank details. What type of cyber threat does this represent?



- (a) Hacking
- (b) Phishing
- (c) Malware
- (d) Software Piracy

Ans :

- (b) Phishing

Phishing is a cybercrime where attackers use fraudulent emails or messages to trick individuals into revealing sensitive information, such as passwords or bank details. Users should verify sources and avoid clicking suspicious links.

74. An image shows a programmer copying software from an unauthorized website. What cybersecurity issue is being demonstrated?



- (a) Ethical Hacking
- (b) Software Piracy
- (c) Cyberbullying
- (d) AI Decision-Making

Ans :

- (b) Software Piracy

Software piracy refers to illegally copying, distributing, or using software without proper authorization. It violates intellectual property rights and may lead to legal consequences. Organizations implement license agreements to prevent unauthorized use.

75. An image shows a doctor using AI-powered software to analyze medical scans. What does this scenario represent?



- (a) AI replacing doctors completely.
- (b) AI assisting in medical diagnosis while doctors make final decisions.
- (c) AI making ethical medical decisions independently.
- (d) AI having emotions and empathy for patients.

**Ans :**

(b) AI assisting in medical diagnosis while doctors make final decisions.

AI enhances medical diagnosis by rapidly analyzing patterns in scans, but final decisions are made by doctors, who apply experience, ethics, and contextual understanding. AI serves as a powerful tool for augmenting human expertise, not replacing it.

## TWO MARK QUESTIONS

- 76.** Define the Turing Test.

**Ans :**

MAIN 2009

The Turing Test, proposed by Alan Turing, involves a human judge conversing via text with both a human and a machine. If the judge cannot distinguish the machine from the human, the machine is said to have passed the test.

- 77.** What is machine intelligence?

**Ans :**

SQP 2014

It refers to AI-driven capabilities where computers learn from data, recognize patterns, and solve problems, mimicking aspects of human cognitive functions though they lack true consciousness or emotion.

- 78.** Why might passing the Turing Test not prove genuine consciousness?

**Ans :**

COMP 2007

A system can mimic human conversation using algorithms and pattern matching without actual self-awareness, meaning it only replicates human-like responses rather than experiencing consciousness.

- 79.** Explain unauthorized use of hardware in one sentence.

**Ans :**

MAIN 2017

It's when someone accesses or operates a device, like a computer or smartphone, without the owner's explicit permission, violating the user's rights and privacy.

- 80.** Give one example of software theft.

**Ans :**

SQP 2010

Illegally copying and distributing a copyrighted software application, such as downloading a cracked version of a commercial program, is a clear instance of software theft.

- 81.** What is data theft in simple terms?

**Ans :**

COMP 2008

Data theft is the unauthorized copying or transfer of private or sensitive information, typically aimed at exploiting it for personal, financial, or malicious gain.

- 82.** Name one criticism of the Turing Test.

**Ans :**

MAIN 2022

It focuses on a machine's ability to deceive rather than genuinely understand or be aware, thus not measuring true consciousness or comprehension.

- 83.** Why is reliability of computer output important?

**Ans :**

SQP 2025

Users often base critical decisions on digital results. If these results are tampered with or incorrect, it can cause financial loss, safety risks, or misinformed actions.

- 84.** Mention one reason hacking is considered unethical.

**Ans :**

COMP 2021

It violates privacy and security by trespassing into systems without consent, potentially leading to theft, damage, or misuse of data.

85. In what way can machine intelligence support cybersecurity?

Ans :

MAIN 2023

AI-powered tools can analyze extensive logs quickly, spotting anomalies or suspicious patterns that human analysts might miss, thereby enhancing threat detection.

86. What is the main goal of the Turing Test?

Ans :

SQP 2024

To evaluate whether a computer's conversational responses can fool a human judge into mistaking it for another human, assessing human-like language abilities.

87. List one example of making false claims for computers.

Ans :

COMP 2006

Advertising a computer system as “unhackable” or “100% secure,” providing a guarantee no system can realistically fulfill.

88. Why is “disputed rights to products” an ethical issue?

Ans :

MAIN 2012

Conflicts over intellectual property or ownership can lead to illegal use, financial loss, and infringements on rightful creators' or inventors' claims.

89. Define “machine intelligence” in contrast to a simple automated process.

Ans :

SQP 2018

Machine intelligence can learn or adapt from data, whereas simple automation follows fixed, unchanging instructions without the capacity for learning.

90. What role does human emotion play in classification tasks compared to machines?

Ans :

COMP 2011

Humans can incorporate emotional or contextual elements, sometimes leading to bias or nuanced judgments. Machines rely solely on algorithmic patterns and data inputs.

91. Give an example of sabotage in the form of viruses.

Ans :

MAIN 2025

Releasing malware that spreads through corporate networks, deleting critical files or locking users out until a ransom is paid, exemplifies virus sabotage.

92. Why might “theft of software” be detrimental to innovation?

Ans :

SQP 2024

Developers lose revenue and motivation to create new products if their work is pirated, reducing investment in research and quality improvements.

93. Mention one way to protect computer systems from hacking.

Ans :

COMP 2013

Implementing strong passwords, firewalls, and regular software updates can block potential exploits, reducing hacking opportunities.

94. How do humans and machines differ in intelligence approach, per Turing's view?

Ans :

MAIN 2019

Humans use intuition and context, while machines replicate human-like responses through programmed logic. Turing's test only evaluates whether the latter can convincingly simulate the former.

95. Explain the concept of “degradation of work” briefly.

Ans :

SQP 2006

As machines automate tasks, some workers lose specialized roles, or skills can atrophy if not regularly practiced, leading to potential unemployment or underemployment issues.

## THREE MARKS QUESTIONS

96. Discuss the significance of the Turing Test in the history of AI.

Ans :

COMP 2017

Proposed by Alan Turing, it was one of the first structured metrics to compare machine outputs with human responses. It ignited debates about intelligence, consciousness, and imitation, guiding early AI goals. Although imperfect, it remains a foundational concept for measuring AI's “human-like” behavior.

- 97.** Why do some experts criticize the Turing Test as an ultimate measure of intelligence?

**Ans :** MAIN 2010

They argue it emphasizes imitation rather than real understanding—machines might fool judges with scripted or pattern-based replies without genuine comprehension. It also ignores other forms of intelligence, such as problem-solving or creativity outside conversation, thus limiting it as a holistic measure.

- 98.** Explain how machine intelligence could collaborate with human intelligence.

**Ans :** SQP 2022

Machines handle large-scale data analysis and repetitive tasks rapidly, while humans bring creativity, empathy, and moral reasoning. Together, they solve complex problems—humans direct or interpret insights from AI outputs, ensuring ethical and context-aware final decisions.

- 99.** Give an example of how cybersecurity threats can disrupt an organization's operations.

**Ans :** COMP 2021

A ransomware attack might encrypt essential files, halting production lines until a ransom is paid. Hacking can expose confidential customer data, leading to legal repercussions and loss of trust, effectively crippling day-to-day functions and finances.

- 100.** Discuss the ethical implications of making false claims about computer systems.

**Ans :** MAIN 2023

Overstating capabilities deceives users or investors, potentially leading to financial losses or harmful reliance on insecure systems. Ethically, transparency builds trust and ensures individuals can make informed decisions about deploying or purchasing technology.

- 101.** How can viruses be introduced into a system, and what is one prevention method?

**Ans :** SQP 2016

Malicious software often arrives via infected email attachments, compromised downloads, or removable media. Using reputable antivirus software and instructing users not to open suspicious links/attachments is a crucial preventive step.

- 102.** Why is “responsibility for reliability of output” becoming more important in AI-driven systems?

**Ans :** COMP 2015

As AI automates critical decisions—healthcare diagnostics, financial predictions—errors or manipulations can have serious consequences. Ensuring that outputs are accurate and ethically derived places onus on developers and users to validate results, set safeguards, and maintain accountability.

- 103.** Explain how machine intelligence can be used to detect fraud in financial systems.

**Ans :** MAIN 2012

ML algorithms analyze transaction patterns to spot anomalies (e.g., unusual spending spikes, location mismatches). If a transaction deviates from typical user profiles, the system flags it for investigation. This rapid pattern recognition outperforms manual checks.

- 104.** Contrast an automated fruit-sorting system using fixed color thresholds with one using machine learning.

**Ans :** SQP 2018

Fixed-threshold automation classifies fruits solely by predefined color cutoffs, failing when color nuances vary. An ML-based system learns from labeled fruit examples, recognizing subtle shades or shapes and adapting to new variations for more accurate sorting.

- 105.** Describe an ethical issue that arises from hacking, even if no data is stolen.

**Ans :** COMP 2014

Unauthorized intrusion violates privacy and trust. It can also compromise system integrity or reveal vulnerabilities to malicious actors. Fear of breach can force costly defensive measures for organizations, creating a climate of insecurity.

- 106.** In what way might the Turing Test be considered incomplete in evaluating AI?

**Ans :** MAIN 2007

It primarily tests conversational mimicry, neglecting other intelligence facets like creativity, emotional understanding, or sensorimotor skills. A system passing the test might still lack genuine understanding or real-world problem-solving capabilities outside textual dialogue.

(d) Assertion is incorrect, but Reason is correct.  
The assertion is incorrect because passing the Turing Test doesn't confirm consciousness. The reason is correct that Turing's format tests a machine's mimicry of human dialogue. Thus, the assertion is wrong, but the reason accurately describes the test's actual scope.

- 52. Assertion (A) :** Unauthorized hardware use includes logging into your personal account with permission.

**Reason (R) :** Using someone else's device without consent is an example of unauthorized access.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct.  
The assertion is incorrect—using your own account or device with rightful access is authorized usage. The reason is correct, highlighting that operating someone else's device without their approval is unauthorized. So, (d) applies : The assertion is wrong, reason is right.

- 53. Assertion (A) :** Machine intelligence always involves emotional processing.

**Reason (R) :** Machines rely on algorithms and data-driven methods, lacking emotional capacity.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct.  
The assertion is incorrect—machine intelligence typically does not include true emotions. The reason is correct : machines process data algorithmically. They do not possess genuine feelings. So, the assertion is wrong, but the reason stands correct.

- 54. Assertion (A) :** Data theft often results in financial and reputational harm.

**Reason (R) :** Cybercriminals can sell or misuse stolen data for personal gain or sabotage.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
Both statements are correct, and the reason explains why data theft leads to harm : criminals exploit the data, causing monetary losses, identity fraud, or damaging an organization's credibility. Hence, the reason effectively explains the assertion, making (a) the correct choice.

- 55. Assertion (A) :** A machine that wins at chess has definitely passed the Turing Test.

**Reason (R) :** The Turing Test checks if a computer can imitate human conversation, not just solve strategic puzzles.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct.  
Beating humans at chess does not equate to passing the Turing Test. The reason is correct that Turing's measure focuses on human-like conversation, not specialized tasks like chess. Therefore, the assertion is incorrect, while the reason is true.

- 56. Assertion (A) :** Hacking is ethical if the system has vulnerabilities.

**Reason (R) :** Ethical hacking involves permissioned attempts to find and fix system flaws.

**Options:**

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(d) Assertion is incorrect, but Reason is correct.

3. Understanding vs. Imitation : Even if it fooled users, question whether it truly grasps context or relies on pattern-based scripts. Additional thorough testing could reveal limitations.

**117.** A school network experiences repeated hacking attempts leading to data theft. Propose a few key measures.

**Ans :**

1. Stronger Authentication : Enforce complex passwords, multi-factor logins.
2. Regular Updates : Patch systems to close vulnerabilities.
3. Monitoring & AI Tools : Deploy intrusion detection (IDS) or anomaly detection.
4. User Education : Train staff and students on phishing and safe practices.

**118.** An automated factory line is set to handle a specific product shape, but the company decides to change designs. What challenges arise, and how could autonomy help?

**Ans :**

1. Challenges : The existing rule-based system might fail with new dimensions or configurations, requiring manual recalibration or reprogramming.
2. Autonomous Upgrade : Incorporate machine vision and adaptive algorithms, so the line recognizes product variances and adjusts on-the-fly, reducing downtime and reconfiguration costs.

**119.** A local government office uses a simple questionnaire-based chatbot to answer FAQs. Users complain it often responds irrelevantly. Could Turing Test principles apply?

**Ans :**

1. Limitation : The bot lacks flexible understanding, producing mismatched replies.
2. Turing Insight : If it fails to convincingly emulate a human conversation, it fails a Turing-like test.
3. Solution : Improve NLP models, expand dataset coverage, or add context awareness to refine relevancy.

**120.** A software firm advertises its product as “the only solution that can never be hacked or infected.” Discuss the ethical concerns.

**Ans :**

1. Overstatement : Declaring absolute security is misleading, creating false confidence in users.
2. Legal/Ethical Impact : If a breach occurs, users might suffer harm, and the firm could face lawsuits.
3. Better Approach : Provide realistic claims, disclaimers, and best-effort security guarantees.

**121.** A research lab wants to build a fruit-sorting machine. Initially, they tried color thresholds, which failed on unusual fruit shades. Explain how ML might help.

**Ans :**

1. Data Collection : Gather images of typical and oddly colored fruits.
2. Training : Teach a model to recognize relevant features (texture, shape) not captured by color alone.
3. Adaptation : The ML approach learns from anomalies or mixed ripeness, outperforming simple thresholds.

**122.** An e-commerce site suffers a data breach, compromising thousands of customers. Suggest three immediate steps.

**Ans :**

1. Contain & Investigate : Isolate affected servers, identify intrusion points, and preserve logs.
2. Notify Stakeholders : Alert customers and regulators promptly, urging password resets.
3. Strengthen Security : Patch vulnerabilities, enhance encryption, and deploy real-time monitoring to prevent further attacks.

**123.** Students create a “Turing Test fair” where visitors chat with hidden “bots” or humans. What learning outcomes might this provide?

**Ans :**

1. Practical Insight : Experiencing how well bots mimic humans reveals the nuances of language-based AI.
2. Critical Thinking : Visitors gauge responses for authenticity or detect patterns in machine replies.
3. AI Limitations : Students see how easily or not machines can be confused with tricky questions or context shifts.

- 124.** A small business tries to reduce software costs by installing unlicensed copies. Outline potential risks.

**Ans :**

1. Legal : Heavy fines or lawsuits for breaching copyright laws.
2. Security : Pirated software often lacks updates, leaving vulnerabilities.
3. Ethical & Reputational : Engaging in illegal activities damages trust with clients and partners.

- 125.** An autonomous system manages tickets in a large call center, analyzing text queries. Some employees worry about job losses. How can management address “degradation of work”?

**Ans :**

1. Upskilling : Offer retraining for staff to handle more complex tasks or system oversight.
2. Role Evolution : Shift employees to customer relationship roles needing empathy and creativity.
3. Transparency : Explain how automation handles routine queries, freeing humans for higher-value interactions rather than total replacement.

# CHAPTER 8

## COMPONENTS OF AI PROJECT FRAMEWORK

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### SUMMARY

#### 1. PROBLEM SCOPING

It is the process of understanding a problem, identifying factors that affect it, and clearly defining the project's goals.

##### 1.1 The 4 Ws

1. Who: Who is affected by the problem and who will use the solution?
2. What: What exactly is the problem and what are the desired outcomes?
3. Where: In which context or environment does the problem occur?
4. Why: Why does the problem need to be solved? What is its significance?

##### 1.2 Problem Statement

1. A clear, concise description of the issue, including objectives, scope, and limitations.
2. Example: "Improve fruit sorting accuracy in our packaging line by identifying factors affecting misclassification."

#### 2. DATA ACQUISITION

##### 2.1 Types of Data

1. Structured Data: Organized in tables (spreadsheets, databases).
2. Unstructured Data: Free text, images, audio.
3. Semi-structured Data: JSON, XML formats.

##### 2.2 Data Features and Sources

1. Features: Attributes or variables (e.g., color, size, weight in fruit sorting).
2. Data Sources: Sensors, databases, surveys, and public repositories.
3. Reliable Sources: Quality, validated sources such as datasets from Kaggle.

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#### 2.3 Training and Testing Data

Data is typically split into training (to build the model) and testing (to evaluate performance).

#### 2.4 System Maps

Visual diagrams that outline data flows and relationships among system components.

#### 2.5 Kaggle Platform

A popular website hosting numerous datasets for AI projects, offering challenges and community support.

#### 3. DATA EXPLORATION

##### 3.1 Purpose

To analyze and visualize data to extract meaningful insights.

##### 3.2 Visualization Tools and Graphs

1. Bar Graphs/Histograms: Display frequency distribution of data.
2. Line Graphs: Show trends over time.
3. Scatter Plots: Reveal correlations between two numerical variables.
4. Pie Charts: Illustrate proportional data distribution.

##### 3.3 Insights Gained

Identify trends, outliers, and relationships among variables to inform model choices.

#### 4. MODELLING AND EVALUATION

##### 4.1 Approaches in AI Data Modelling

1. Prediction – Linear Regression: A statistical method to predict continuous outcomes using linear relationships.
2. Rule-Based Approach: Uses if-then rules to make decisions (deterministic).
3. Learning-Based Approach: Uses algorithms to learn from data, including:

Ans :

MAIN 2022

(b) System Map

In this case, the project team develops a visual diagram, known as a system map, to illustrate the flow of data among various components. This map clarifies how sensors, controllers, and databases interact, facilitating better understanding, troubleshooting, and optimization of the overall system architecture during the project development phase effectively.

- 39.** A data analyst accesses high-quality datasets and participates in competitions on Kaggle.

What is one major benefit of using Kaggle?

- (a) It manufactures hardware
- (b) It provides quality datasets and community support
- (c) It replaces data exploration
- (d) It automates model training

Ans :

MAIN 2025

(b) It provides quality datasets and community support

In this scenario, Kaggle offers a platform with quality datasets, challenges, and active community support. These resources enable data scientists to access reliable data, share insights, and benchmark their models against peers. Kaggle fosters collaboration and continuous learning, accelerating model development and innovation in data-driven projects with significant impact.

- 40.** A municipal government plans a smart traffic system by asking: Who is affected, What is the issue, Where does it occur, and Why is it significant.

Which framework are they applying?

- (a) The 3 Cs
- (b) The 4 Ws
- (c) Data Acquisition
- (d) System Mapping

Ans :

SQP 2021

(b) The 4 Ws

In this case, the municipal government employs the 4 Ws framework—Who, What, Where, and Why—to comprehensively scope the traffic problem. This approach ensures that all aspects, including affected stakeholders, specific issues, contextual settings, and underlying significance, are analyzed, forming a foundation for developing effective smart traffic solutions efficiently.

- 41.** Which statement best describes the purpose of problem scoping?

- (a) It defines the project's data storage requirements.
- (b) It outlines the problem's objectives, affected stakeholders, and scope using the 4 Ws.
- (c) It details the programming language to be used.
- (d) It only focuses on technical specifications.

Ans :

COMP 2023

(b) It outlines the problem's objectives, affected stakeholders, and scope using the 4 Ws.

Problem scoping involves clearly defining the problem, including who is affected, what the problem is, where it occurs, and why it is significant. This comprehensive understanding directs the project's goals and subsequent phases, making option B the best summary.

Which statement about data acquisition is correct?

- (a) Data acquisition is not necessary if you have a strong algorithm.
- (b) Acquiring high-quality and relevant data is essential for reliable model training.
- (c) Data acquisition focuses solely on gathering as much data as possible, regardless of quality.
- (d) Data acquisition is only about collecting images.

Ans :

MAIN 2024

(b) Acquiring high-quality and relevant data is essential for reliable model training.

The quality and relevance of data directly influence the accuracy of any model. High-quality data ensures that the training process leads to a model that generalizes well. Thus, acquiring reliable data is critical, making option B correct.

- 43.** Which statement about data exploration is correct?

- (a) Data exploration is only about creating pie charts.
- (b) Data exploration involves using visual tools like histograms and scatter plots to understand the data.
- (c) Data exploration is unnecessary if the data is already labeled.
- (d) Data exploration replaces the need for data acquisition.

Ans :

SQP 2013

(b) Data exploration involves using visual tools

7. What type of graph is best for showing the frequency distribution of a dataset?
- Line graph
  - Pie chart
  - Histogram
  - Scatter plot

Ans :

MAIN 2016

- (c) Histogram

Histograms display the frequency distribution of numerical data by grouping values into bins. They are ideal for understanding data spread and identifying patterns such as skewness or multimodality.

8. Which graph is most appropriate for visualizing the trend of a variable over time?
- Bar graph
  - Line graph
  - Scatter plot
  - Pie chart

Ans :

SQP 2014

- (b) Line graph

Line graphs are effective for depicting trends over time, as they plot continuous data points and show the progression or decline of a variable clearly.

9. What does supervised learning require that unsupervised learning does not?
- Large amounts of data
  - Labeled data
  - Data visualization
  - Statistical analysis

Ans :

COMP 2010

- (b) Labeled data

Supervised learning models require labeled data to learn the mapping between inputs and outputs, while unsupervised learning identifies patterns in data without labels.

10. Which modelling approach is typically used for predicting continuous outcomes?
- Clustering
  - Linear regression
  - Decision trees
  - Rule-based systems

Ans :

MAIN 2023

- (b) Linear regression

Linear regression is a prediction model used to estimate continuous values by finding the

linear relationship between the independent and dependent variables.

11. Which approach in AI uses if-then rules to make decisions?
- Learning-based approach
  - Rule-based approach
  - Unsupervised learning
  - Neural networks

Ans :

SQP 2018

- (b) Rule-based approach

Rule-based approaches rely on explicitly programmed if-then rules to reach decisions, making them deterministic and less adaptable compared to learning-based methods.

12. What is a key benefit of unsupervised learning?
- It requires labeled data
  - It can discover hidden patterns in data without prior labels
  - It guarantees perfect predictions
  - It is the same as supervised learning

Ans :

COMP 2008

- (b) It can discover hidden patterns in data without prior labels

Unsupervised learning methods identify inherent structures or patterns in data without the need for labeled examples, making them useful for clustering and anomaly detection.

13. Which method is best suited for making predictions based on a linear relationship?
- Linear regression
  - K-means clustering
  - Decision tree classification
  - Random forest

Ans :

MAIN 2015

- (a) Linear regression

Linear regression assumes a linear relationship between the dependent and independent variables, making it ideal for predicting continuous outcomes when such a relationship exists.

14. What is the primary role of data exploration in an AI project?
- To train the model directly
  - To generate visual representations that reveal patterns and insights
  - To deploy the final application
  - To write the source code

Ans :

SQP 2007

Ans :

SQP 2019

(b) A system that uses predefined if-then rules to make decisions

A rule-based system operates on a set of fixed, predetermined if-then rules. Unlike learning-based approaches, it does not adapt from data. It is used in environments where the logic can be clearly defined and does not require model training.

**28.** Which statement best describes supervised learning?

- (a) It uses unlabeled data to find hidden patterns
- (b) It relies on labeled data to train models to predict outcomes
- (c) It randomly assigns labels to data
- (d) It does not require any model evaluation

Ans :

COMP 2006

(b) It relies on labeled data to train models to predict outcomes

Supervised learning trains a model on a dataset where each input has a corresponding label. The model learns to map inputs to outputs, allowing for prediction on new, unseen data. Unsupervised learning, by contrast, finds patterns in unlabeled data.

**29.** What is the main goal of model evaluation in an AI project?

- (a) To check if the model works only on the training data
- (b) To determine the model's performance on unseen data and generalize its predictive power
- (c) To increase the number of features
- (d) To ignore errors in predictions

Ans :

MAIN 2012

(b) To determine the model's performance on unseen data and generalize its predictive power  
Model evaluation tests how well a trained model performs on new data (testing set) to ensure it can generalize beyond the training set. This step is critical to confirm that the model's predictions are reliable and accurate in real-world applications.

**30.** Which of the following best summarizes the modelling and evaluation phase in AI?

- (a) Creating visual graphs only
- (b) Training a model using a chosen approach and then assessing its performance using evaluation metrics
- (c) Collecting raw data

(d) Writing the project's problem statement

Ans :

SQP 2018

(b) Training a model using a chosen approach and then assessing its performance using evaluation metrics

The modelling and evaluation phase involves choosing a suitable approach (e.g., linear regression, rule-based, supervised learning), training the model on available data, and then evaluating its performance using appropriate metrics to ensure the model meets the desired objectives.

**31.** A manufacturing company struggles with recurring product quality issues and wants to define clear goals.

Which aspect of problem scoping identifies who is affected by the problem and who will use the solution?

- (a) What
- (b) Where
- (c) Who
- (d) Why

Ans :

COMP 2011

(c) Who

In this scenario, effective problem scoping starts with identifying stakeholders. The 'Who' component clarifies who is affected by the quality issues and who will benefit from the solution. This identification ensures that improvement measures address all relevant parties, leading to actions and higher overall satisfaction with the final outcome effectively.

**32.** A startup aims to improve fruit sorting accuracy on its packaging line. The team needs a clear description of the issue.

Which element is crucial for a proper problem statement?

- (a) Vague description
- (b) Clear, concise description including objectives, scope, and limitations
- (c) List of symptoms only
- (d) Objectives only

Ans :

MAIN 2009

(b) Clear, concise description including objectives, scope, and limitations

In this scenario, the startup must develop a clear problem statement. A concise description including objectives, scope, and limitations is crucial for understanding sorting inaccuracies. It

- 21.** Which of the following is an example of supervised learning?
- (a) Grouping similar customers without prior labels
  - (b) Predicting house prices using historical sales data with known prices
  - (c) Discovering hidden topics in text data
  - (d) Clustering documents based on similarity

**Ans :** SQP 2021

(b) Predicting house prices using historical sales data with known prices

Supervised learning uses labeled data where the outcome is known. Predicting house prices by learning from historical data with known values is a typical example, whereas clustering or topic modeling (unsupervised learning) does not rely on labels.

- 22.** Which of the following is NOT a common visualization tool used in data exploration?

- (a) Bar graphs
- (b) Histograms
- (c) Scatter plots
- (d) Neural networks

**Ans :** COMP 2023

(d) Neural networks

Neural networks are algorithms used in machine learning for pattern recognition and predictions, not a method of data visualization. Bar graphs, histograms, and scatter plots are standard tools to visually analyze data.

- 23.** Why is acquiring relevant data from reliable sources important in AI?

- (a) It reduces the need for data exploration
- (b) It ensures that the model is trained on accurate and representative information
- (c) It increases the complexity of the project
- (d) It allows for using any data regardless of quality

**Ans :** MAIN 2024

(b) It ensures that the model is trained on accurate and representative information

High-quality, reliable data is crucial for training effective AI models. Inaccurate or biased data can lead to poor model performance and incorrect conclusions. Reliable sources, such as Kaggle, help ensure that the insights derived from the data are valid.

- 24.** Which of the following is a typical data source for AI projects?

- (a) Personal diaries

- (b) Kaggle datasets
- (c) Random internet comments
- (d) Unverified social media posts

**Ans :** SQP 2013

(b) Kaggle datasets

Kaggle is a reputable platform that provides curated datasets for various AI projects. These datasets are widely used by the community for training and testing models, ensuring high-quality data for analysis.

- 25.** What is the purpose of data exploration in an AI project?

- (a) To automatically train a machine learning model
- (b) To visually and statistically understand data properties and relationships
- (c) To write complex code without understanding data
- (d) To deploy the final AI system

**Ans :** COMP 2016

(b) To visually and statistically understand data properties and relationships

Data exploration is used to analyze data through visualizations and statistics. This process helps identify trends, outliers, and relationships, guiding the selection of appropriate modelling techniques and ensuring the data is well understood before model training.

- 26.** Which modelling approach is best for predicting a continuous variable?

- (a) Clustering
- (b) Linear regression
- (c) Decision tree classification
- (d) K-means

**Ans :** MAIN 2015

(b) Linear regression

Linear regression is a predictive modelling technique that estimates the relationship between dependent and independent variables. It is specifically used for predicting continuous outcomes, making it ideal for scenarios where numerical prediction is required.

- 27.** What is a rule-based approach in AI modelling?

- (a) A method where outcomes are learned from data without explicit instructions
- (b) A system that uses predefined if-then rules to make decisions
- (c) A form of unsupervised learning
- (d) A technique for visualizing data

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- (i) Supervised Learning: Uses labeled data (e.g., classification, regression).
- (ii) Unsupervised Learning: Finds patterns without labels (e.g., clustering).

## 5. EVALUATION

1. Assess the performance of the model (accuracy, precision, recall, error rate).
2. Testing against a separate dataset to validate performance.

## MULTIPLE CHOICE QUESTION

1. What is the primary purpose of problem scoping in an AI project?
  - (a) To develop a working prototype
  - (b) To understand and define the problem and its goals
  - (c) To implement code immediately
  - (d) To deploy a system online

Ans :

MAIN 2025

- (b) To understand and define the problem and its goals

Problem scoping is the initial phase where the project's challenges, factors affecting it, and desired outcomes are identified using the 4 Ws (Who, What, Where, Why). This clarity helps direct the subsequent data and modelling efforts.

2. Which of the following best represents the "Who" in the 4 Ws of problem scoping?
  - (a) The data sources
  - (b) The stakeholders affected by the problem
  - (c) The software used
  - (d) The programming language

Ans :

SQP 2006

- (b) The stakeholders affected by the problem  
"Who" addresses the people impacted by the problem or who will benefit from the solution, including end-users, clients, or stakeholders, making it essential for tailoring the project's objectives.

3. What does a problem statement in an AI project do?
  - (a) Lists the programming languages to be used
  - (b) Provides a clear description of the issue and goals
  - (c) Explains the hardware specifications

- (d) Details every step of the algorithm

Ans :

COMP 2013

- (b) Provides a clear description of the issue and goals

The problem statement concisely outlines the issue, objectives, and scope of the project, guiding subsequent phases such as data acquisition, exploration, and modelling.

4. Which is an example of structured data?
  - (a) A handwritten note
  - (b) An Excel spreadsheet containing sensor readings
  - (c) A collection of photos
  - (d) Audio recordings

Ans :

MAIN 2009

- (b) An Excel spreadsheet containing sensor readings

Structured data is organized in a fixed format such as tables in spreadsheets or databases, allowing for easy querying and analysis. Sensor readings in an Excel file are typical examples.

5. What is the main goal of data acquisition in an AI project?
  - (a) To create visualizations
  - (b) To gather relevant, high-quality data from reliable sources
  - (c) To deploy a software application
  - (d) To build hardware prototypes

Ans :

SQP 2021

- (b) To gather relevant, high-quality data from reliable sources

Data acquisition involves collecting necessary data that is accurate and relevant to the problem. Reliable sources, such as Kaggle datasets, ensure that the subsequent modelling and evaluation are based on sound information.

6. Which of the following is a reliable source for datasets in AI?
  - (a) Random internet forums
  - (b) Kaggle
  - (c) Unverified blogs
  - (d) Social media posts

Ans :

COMP 2012

- (b) Kaggle

Kaggle is a well-known platform hosting numerous datasets that are curated and widely used in the AI community. It is a reputable source for obtaining high-quality data for training and testing models.

ensures that all stakeholders share understanding and that project goals remain focused, guiding data acquisition and model development with clear strategic direction effectively.

- 33.** A research team gathers sensor readings and downloads datasets from public repositories like Kaggle for a predictive model.

Which types of data are they likely working with?

- (a) Only unstructured data
- (b) Only structured data
- (c) Both structured and unstructured data
- (d) Only semi-structured data

Ans :

SQP 2014

- (c) Both structured and unstructured data

In this scenario, the team gathers data from sensors and public repositories. Sensor data is typically structured, while images, texts, or audio from repositories can be unstructured. Combining both types enriches the model's feature set, enabling comprehensive analysis and improved predictions by leveraging diverse data formats for success effectively.

- 34.** A company visualizes sales data trends using scatter plots and histograms to identify correlations.

What is the primary purpose of data exploration in this context?

- (a) To build the final model immediately
- (b) To analyze and extract insights
- (c) To deploy the model
- (d) To ignore outliers

Ans :

COMP 2007

- (b) To analyze and extract insights

In this case, data exploration uses visual tools like scatter plots and histograms to reveal trends, correlations, and outliers in sales data. This analysis provides insights that guide model selection and development. It is a necessary step to ensure that the final predictive model captures underlying patterns in the dataset effectively.

- 35.** A data scientist applies linear regression to predict sales based on advertising spend.

What approach does this represent?

- (a) Rule-based approach
- (b) Prediction – linear regression
- (c) Unsupervised learning
- (d) Decision tree

Ans :

MAIN 2017

- (b) Prediction – linear regression

In this scenario, the data scientist applies linear regression, a statistical prediction method that models the relationship between advertising spend and sales. This approach falls under the prediction category of AI data modelling. It uses a mathematical relationship to forecast outcomes, providing a quantitative basis for future sales predictions effectively.

- 36.** A team developing a fruit sorting system collects data on attributes such as color, size, and weight. What do these attributes represent?

- (a) Data sources
- (b) Data features
- (c) Training data
- (d) System maps

Ans :

SQP 2010

- (b) Data features

In this case, the attributes such as color, size, and weight are data features. They represent the measurable characteristics of fruits that are critical for building a classification model. Understanding these features helps in selecting algorithms and designing effective data acquisition strategies, enhancing the accuracy of the fruit sorting system effectively.

- 37.** A data scientist splits the dataset into two parts: one for training and one for evaluation.

What is the purpose of the testing data?

- (a) To build the model
- (b) To evaluate model performance
- (c) To create features
- (d) To modify training data

Ans :

COMP 2008

- (b) To evaluate model performance

In this scenario, testing data is separated from training data to evaluate model performance on unseen examples. It ensures that the model's predictive accuracy is not overestimated due to overfitting. By validating the model with testing data, the scientist can assess its generalization capability and make necessary improvements reliably.

- 38.** A project team creates a visual diagram showing the flow of data among sensors, controllers, and databases.

What is this diagram called?

- (a) Data Exploration Chart
- (b) System Map
- (c) Training Data Diagram
- (d) Feature Flow Chart

(b) To generate visual representations that reveal patterns and insights

Data exploration involves creating visualizations (bar graphs, scatter plots, etc.) to understand the data's distribution, relationships, and trends, which helps in selecting appropriate modelling techniques.

**15.** In the context of AI, what does “data features” refer to?

- (a) The visual layout of a dataset
- (b) The individual measurable properties or attributes of data points
- (c) The storage location of the data
- (d) The number of data sources available

**Ans :**

COMP 2024

(b) The individual measurable properties or attributes of data points

Data features are the individual measurable characteristics or variables (e.g., color, weight, size) that help describe each data point and are used as inputs for AI models.

**16.** Why is it important to split data into training and testing sets?

- (a) To reduce the size of the dataset
- (b) To evaluate how well the model generalizes to unseen data
- (c) To speed up data acquisition
- (d) To enhance data visualization

**Ans :**

MAIN 2011

(b) To evaluate how well the model generalizes to unseen data

Splitting the dataset into training and testing sets allows the model to be trained on one subset and then evaluated on another to assess its performance on unseen data, thereby measuring its generalization capability.

**17.** What is a system map in the context of data acquisition?

- (a) A geographic map showing sensor locations
- (b) A diagram showing the flow and interaction between various data sources and system components
- (c) A list of programming languages used
- (d) A physical blueprint of a computer

**Ans :**

SQP 2022

(b) A diagram showing the flow and interaction between various data sources and system components

A system map visually represents how data flows between different components of the system, illustrating relationships and interactions that are crucial for understanding overall system architecture.

**18.** Which data visualization method is most effective for comparing parts of a whole?

- (a) Line graph
- (b) Bar graph
- (c) Scatter plot
- (d) Pie chart

**Ans :**

COMP 2019

(d) Pie chart

Pie charts are ideal for showing how different segments contribute to a whole by representing each category as a slice of the pie. This makes it easy to compare relative proportions at a glance.

**19.** Which of the following best describes the “rule-based approach” in AI modelling?

- (a) An approach that learns from examples
- (b) An approach that relies on manually defined if-then rules
- (c) An unsupervised learning method
- (d) A method for data visualization

**Ans :**

MAIN 2017

(b) An approach that relies on manually defined if-then rules

The rule-based approach uses explicitly programmed rules (if-then statements) to make decisions. This method does not adapt automatically from data and is more static compared to learning-based approaches.

**20.** What is the main objective of evaluating a model in AI?

- (a) To increase the dataset size
- (b) To measure the model's performance on unseen data
- (c) To create new data features
- (d) To visualize data distributions

**Ans :**

MAIN 2025

(b) To measure the model's performance on unseen data

Evaluation involves testing the model on a separate dataset to determine its accuracy, precision, and overall ability to generalize. This step is crucial to ensure the model's effectiveness in real-world scenarios.

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like histograms and scatter plots to understand the data.

Data exploration employs various visualization techniques—such as bar graphs, histograms, scatter plots, and line graphs—to reveal trends, outliers, and relationships within the data. This process helps in understanding the data before modelling, making option B correct.

**44.** Which statement correctly describes linear regression?

- (a) Linear regression is used for classifying objects into categories.
- (b) Linear regression predicts continuous outcomes by modeling linear relationships between variables.
- (c) Linear regression is a type of unsupervised learning.
- (d) Linear regression uses if-then rules to make decisions.

**Ans :**

COMP 2016

(b) Linear regression predicts continuous outcomes by modeling linear relationships between variables.

Linear regression is a predictive modelling technique that fits a linear equation to observed data, enabling the prediction of continuous outcomes. It is not used for classification or rule-based decisions, so option B is the accurate description.

**45.** Which statement about supervised learning is correct?

- (a) It uses unlabeled data exclusively.
- (b) It trains models on labeled data to learn input-output mappings.
- (c) It is identical to unsupervised learning.
- (d) It does not require evaluation on test data.

**Ans :**

MAIN 2015

(b) It trains models on labeled data to learn input-output mappings.

Supervised learning involves training models using labeled datasets where each input is paired with the correct output. This approach enables the model to learn and later predict outcomes accurately, making option B correct.

**46.** Which statement about unsupervised learning is correct?

- (a) It relies on explicit labels for every data point.
- (b) It finds hidden patterns in data without using labeled outcomes.

- (c) It always produces clear, distinct clusters.
- (d) It is used for predicting future trends directly.

**Ans :**

SQP 2019

(b) It finds hidden patterns in data without using labeled outcomes.

Unsupervised learning methods analyze data without pre-assigned labels to discover underlying patterns or clusters. It does not require labels and is useful for exploratory data analysis, so option B is correct.

**47.** Which statement about system maps in data acquisition is correct?

- (a) They only show the physical layout of hardware.
- (b) They are visual diagrams that outline the flow of data between system components.
- (c) They are used exclusively for project budgeting.
- (d) They replace the need for data exploration.

**Ans :**

COMP 2006

(b) They are visual diagrams that outline the flow of data between system components.

System maps visually represent how data moves through various components of a system, helping to clarify relationships and workflows. They are a crucial planning tool in data acquisition, making option B correct.

**48.** Which statement regarding data features is accurate?

- (a) Data features are irrelevant in AI modelling.
- (b) Data features are the measurable attributes that describe each data point.
- (c) Data features are the physical appearance of data charts.
- (d) Data features only exist in unstructured data.

**Ans :**

MAIN 2012

(b) Data features are the measurable attributes that describe each data point.

Data features are individual measurable properties or variables (such as color, size, or weight) that describe each data point in a dataset. They are fundamental to building effective models, so option B is correct.

**49.** Which statement best describes the role of evaluation in AI modelling?

- (a) Evaluation is unnecessary if the model performs well on training data.
- (b) Evaluation tests a model on unseen data to verify its generalizability.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are correct, and the reason explains why rule-based systems are rigid—they do not adjust based on new input, unlike learning-based methods that can update and refine predictions over time.

- 60. Assertion (A) :** The Kaggle platform is a valuable resource for acquiring datasets in AI.

**Reason (R) :** Kaggle provides a variety of curated datasets and competitions that help researchers test and improve their models.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are true, and the reason correctly explains Kaggle's value. It offers diverse, high-quality data and challenges that foster learning and innovation in machine learning and AI.

## STATEMENT BASED QUESTIONS

- 61.** Consider the following statements about the definition of problem scoping:

1. Problem scoping is the process of understanding a problem, identifying the factors that affect it, and clearly defining the project's goals.
  2. Problem scoping is solely about identifying the desired outcomes of a project.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

Ans :

(a) Only statement 1 is correct.  
The material defines problem scoping as a comprehensive process that includes understanding the problem, identifying affecting factors, and defining project goals. Statement 2 is too narrow since it ignores the understanding and

identification aspects.

- 62.** Consider the following statements about the “4 Ws” in problem scoping:

1. The “4 Ws” refer to Who, What, Where, and Why.
  2. The “4 Ws” include Who, When, What, and Where.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

Ans :

(a) Only statement 1 is correct.  
According to the material, the “4 Ws” are Who, What, Where, and Why. Statement 2 is incorrect because it incorrectly substitutes “When” for “Why.”

- 63.** Consider the following statements about writing a problem statement:

1. A problem statement provides a clear and concise description of the issue, including objectives, scope, and limitations.
  2. A problem statement should be vague to allow for flexibility in interpretation.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

Ans :

(a) Only statement 1 is correct.  
The material emphasizes that a problem statement must be clear and concise, outlining objectives, scope, and limitations. Statement 2 is incorrect because vagueness contradicts the purpose of having a well-defined problem statement.

- 64.** Consider the following statements about types of data in data acquisition:

1. Structured data is organized in tables, such as those found in spreadsheets or databases.
  2. Unstructured data is typically represented in JSON or XML formats.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

Ans :

(a) Only statement 1 is correct.  
Structured data is indeed organized in tables. JSON and XML formats are examples of

- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are true, and the reason correctly explains how linear regression works. It shows the direct relationship between independent and dependent variables, making it effective for predicting continuous outcomes.

- 55. Assertion (A) :** Supervised learning requires labeled data for training models.

**Reason (R) :** Labeled data provides the ground truth that the algorithm uses to learn and make predictions.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are correct, and the reason explains why supervised learning depends on labeled data. Labels enable the model to learn the mapping between input features and the correct output.

- 56. Assertion (A) :** Unsupervised learning is useful for discovering patterns without pre-assigned labels.

**Reason (R) :** Unsupervised learning algorithms cluster or reduce data dimensions to find inherent structures in the data.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are true, and the reason accurately explains the purpose of unsupervised learning. These algorithms help uncover hidden patterns and group similar data points, even without labeled examples.

- 57. Assertion (A) :** Acquiring data from reliable sources is critical for model accuracy.

**Reason (R) :** High-quality data minimizes errors and biases, leading to more accurate and generalizable models.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are correct, and the reason correctly explains that quality data is essential to avoid skewed or erroneous models. Reliable sources ensure that the model learns true patterns rather than noise.

- 58. Assertion (A) :** Bar graphs and histograms are effective tools for data exploration.

**Reason (R) :** They help visualize the distribution and frequency of data points, revealing trends and anomalies.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
Both statements are true, and the reason correctly explains that these visualization tools allow analysts to quickly assess the spread and concentration of data, which is critical for understanding and preparing the data for modelling.

- 59. Assertion (A) :** The rule-based approach in AI is less flexible than learning-based approaches.

**Reason (R) :** Rule-based systems rely on fixed if-then conditions, whereas learning-based systems can adapt from new data.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

System maps visually illustrate how data flows between various components of a system. They help identify data sources, integration points, and potential bottlenecks, ensuring that the entire data ecosystem is well understood.

- 107.** How does data exploration contribute to model development?

**Ans :**

COMP 2017

Data exploration uncovers trends, correlations, and anomalies through visualizations, which guide feature selection and model choice. It ensures that the underlying data characteristics are well understood, thereby informing better modelling strategies.

- 108.** Why is model evaluation essential in AI?

**Ans :**

MAIN 2009

Model evaluation measures how well a trained model performs on unseen data, ensuring it generalizes beyond the training set. This step is vital to identify overfitting or underfitting and to refine the model for optimal real-world performance.

- 109.** Explain the supervised learning process with an example.

**Ans :**

SQP 2024

In supervised learning, a model is trained using labeled data (e.g., images of fruits labeled as “apple” or “banana”). The model learns to associate features with the correct label and can then classify new images based on those learned patterns.

- 110.** What is unsupervised learning, and what is its primary application?

**Ans :**

COMP 2010

Unsupervised learning involves identifying patterns in data without pre-assigned labels. It is commonly used for clustering, anomaly detection, and discovering hidden structures in data.

- 111.** Describe one real-world example where linear regression might be used.

**Ans :**

MAIN 2023

Linear regression can be used to predict housing prices based on factors like square footage, location, and age of the property. This helps real estate agencies and buyers estimate fair market values.

- 112.** How can poor data quality affect an AI project?

**Ans :**

SQP 2018

Poor data quality can lead to inaccurate models, biased predictions, and unreliable outcomes. It may result from missing values, errors, or noise, undermining the entire AI solution’s credibility and performance.

- 113.** Why is it important to use multiple data visualization methods during data exploration?

**Ans :**

COMP 2022

Different visualization methods reveal various aspects of the data. For instance, histograms show distribution, scatter plots reveal correlations, and bar graphs compare categorical data. Using multiple methods provides a comprehensive understanding of the dataset.

- 114.** What is the importance of ethical considerations in data acquisition?

**Ans :**

MAIN 2013

Ethical data acquisition ensures that data is collected legally, with consent, and without bias. This protects privacy, upholds legal standards, and builds trust, which is essential for both model accuracy and public acceptance of AI systems.

- 115.** Summarize the modelling and evaluation phase in AI.

**Ans :**

SQP 2017

This phase involves selecting an appropriate modelling technique (e.g., linear regression, supervised learning), training the model on quality data, and then rigorously evaluating its performance on test data. The goal is to ensure the model reliably predicts or classifies new data.

## CASE BASED QUESTION

- 116.** A startup wants to develop an AI model to predict customer churn. Explain how they should start with problem scoping.

**Ans :**

They must define the problem by asking the 4 Ws: Who are the customers at risk, what factors indicate churn, where does churn occur (in which segments), and why it matters (financial impact).

semi-structured data, not unstructured data; unstructured data includes free text, images, and audio.

**65.** Consider the following statements about data features and sources:

1. Features are the attributes or variables (e.g., color, size, weight) used to describe data in a problem like fruit sorting.
  2. Reliable data sources can include validated datasets from platforms such as Kaggle.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.  
The material states that features refer to the descriptive attributes of data and that reliable sources include validated datasets from platforms like Kaggle.

**66.** Consider the following statements about training and testing data:

1. Data is typically split into training data to build the model and testing data to evaluate its performance.
  2. Testing data is used to build the model, while training data is used solely for evaluation.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.  
The material clarifies that the training set is used to build (train) the model and the testing set is used to evaluate its performance. Statement 2 reverses these roles and is therefore incorrect.

**67.** Consider the following statements about system maps and the Kaggle platform:

1. System maps are visual diagrams that outline data flows and the relationships among system components.
  2. Kaggle is a platform that hosts numerous datasets and offers challenges and community support for AI projects.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.  
Both statements accurately reflect the material: system maps illustrate data flows and component relationships, and Kaggle is a popular platform for datasets, competitions, and community support.

**68.** Consider the following statements about data exploration:

1. Data exploration is the process of analyzing and visualizing data to extract meaningful insights such as trends, outliers, and relationships among variables.
  2. Data exploration does not involve using visualization tools like bar graphs, line graphs, scatter plots, or pie charts.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.  
The material describes data exploration as a process that heavily relies on visualization tools (bar graphs, line graphs, scatter plots, pie charts) to extract insights. Statement 2 is incorrect because it denies the role of these visualization tools.

**69.** Consider the following statements about approaches in AI data modeling:

1. A learning-based approach includes both supervised learning, which uses labeled data, and unsupervised learning, which finds patterns without labels.
  2. A rule-based approach uses if-then rules to make decisions and is considered a form of learning-based approach.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.  
The material distinguishes learning-based approaches (including supervised and unsupervised learning) from rule-based approaches. A rule-based approach is deterministic and does not involve learning from data, so statement 2 is incorrect.

**79.** Name two types of data.

**Ans :**

MAIN 2024

Structured data (e.g., spreadsheets) and unstructured data (e.g., text or images).

**80.** What are data features?

**Ans :**

MAIN 2007

Data features are individual measurable properties or attributes that describe each data point.

**81.** Why is reliable data acquisition important?

**Ans :**

SQP 2017

Reliable data ensures that models are trained on accurate, relevant information, which leads to better performance and generalizability.

**82.** What is the Kaggle platform used for?

**Ans :**

COMP 2010

Kaggle is a platform that provides access to curated datasets and AI competitions, helping researchers and practitioners find quality data for projects.

**83.** What is data exploration?

**Ans :**

MAIN 2008

Data exploration is the process of visually and statistically analyzing data to understand its distribution, trends, and relationships.

**84.** Name one visualization tool for data exploration.

**Ans :**

SQP 2022

Histograms are commonly used to visualize the frequency distribution of data.

**85.** What does a scatter plot show?

**Ans :**

MAIN 2025

A scatter plot displays the relationship or correlation between two numerical variables.

**86.** Define linear regression.

**Ans :**

SQP 2021

Linear regression is a predictive modelling technique that fits a linear equation to the data to predict a continuous outcome.

**87.** What is the rule-based approach in AI?

**Ans :**

COMP 2015

It is a method where decisions are made using

predefined if-then rules rather than learning from data.

**88.** How does supervised learning differ from unsupervised learning?

**Ans :**

MAIN 2019

Supervised learning uses labeled data to train models, while unsupervised learning identifies patterns in unlabeled data.

**89.** What is the primary purpose of model evaluation?

**Ans :**

SQP 2012

To assess the model's performance on unseen data and ensure that it generalizes well.

**90.** Why is data preprocessing important?

**Ans :**

COMP 2009

Preprocessing cleans and formats raw data, removing noise and inconsistencies, which improves model accuracy.

**91.** What is a system map?

**Ans :**

MAIN 2014

A system map is a diagram that shows how data flows and interacts among various components of a system.

**92.** What is the benefit of visualizing data with a line graph?

**Ans :**

SQP 2011

Line graphs effectively display trends and changes over time.

**93.** Define prediction in the context of AI modelling.

**Ans :**

COMIP 2017

Prediction involves using a model to forecast unknown or future values based on historical data.

**94.** What is the significance of training and testing data?

**Ans :**

MAIN 2013

Training data is used to build the model, while testing data is used to evaluate its performance on unseen examples.

**95.** Why is it important to use multiple evaluation metrics?

**Ans :**

COMP 2023

Using multiple metrics (accuracy, precision,

- (a) Encrypting Data
- (b) Data Exploration
- (c) Model Training
- (d) Cybersecurity Analysis

Ans :

- (b) Data Exploration

Data exploration involves analyzing and visualizing data to identify patterns, trends, and relationships. Graphs such as bar charts, scatter plots, and histograms help in making sense of large datasets before building AI models.

74. An image displays a dataset being divided into two parts: 8 for training and 2 for testing. What does this step represent?



- (a) Data Encryption
- (b) Training and Testing Data Split
- (c) Data Cleaning
- (d) Cyber Threat Analysis

Ans :

- (b) Training and Testing Data Split

AI models are trained using a portion of the data (training set) and tested on unseen data (testing set) to evaluate performance. This prevents overfitting and ensures the model generalizes well.

75. The image shows an AI model predicting house prices using a graph comparing predicted vs. actual prices. The labels include metrics such as accuracy, precision, recall, and error rate. What is this process called?



- (a) Data Collection
- (b) Model Evaluation
- (c) Feature Engineering
- (d) Cybersecurity Testing

Ans :

- (b) Model Evaluation

Model evaluation measures how well an AI model performs using metrics like accuracy (correct predictions), precision (relevant positive cases), recall (sensitivity), and error rate (wrong predictions). This ensures the reliability of AI predictions.

## TWO MARKS QUESTIONS

76. Define problem scoping.

Ans :

MAIN 2023

Problem scoping is the process of understanding and defining the issue, including its scope, affected stakeholders, and objectives, often using the 4 Ws (Who, What, Where, Why).

77. What are the 4 Ws in problem scoping?

Ans :

SQP 2009

They refer to Who is affected, What the problem is, Where it occurs, and Why it is important to address it.

78. What is a problem statement?

Ans :

COMP 2014

It is a clear, concise description of the issue to be solved, outlining objectives, scope, and limitations.

- (c) Evaluation is only about visualizing output charts.
- (d) Evaluation replaces the need for model training.

Ans :

SQP 2018

(b) Evaluation tests a model on unseen data to verify its generalizability.

Evaluation is a critical step where the model is tested on a separate, unseen dataset to measure its performance and generalizability. This ensures that the model works well beyond the training data, making option B correct.

50. Which statement best summarizes the purpose of modelling in AI?
- (a) To collect raw data from various sources
  - (b) To represent real-world relationships mathematically for prediction or classification
  - (c) To visualize data distributions with charts
  - (d) To manually label all data points

Ans :

COMP 2011

(b) To represent real-world relationships mathematically for prediction or classification  
Modelling in AI involves using mathematical or algorithmic representations (like linear regression or neural networks) to predict outcomes or classify inputs based on learned relationships. It is a core step after data acquisition and exploration, making option B correct.

## ASSERTION AND REASON

51. **Assertion (A)** : A clear problem statement is essential for the success of an AI project.  
**Reason (R)** : A problem statement defines the project's objectives, scope, and affected stakeholders using the 4 Ws.
- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
  - (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
  - (c) Assertion is correct, but Reason is incorrect.
  - (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
Both statements are correct, and the reason correctly explains why a clear problem statement

is vital. It guides data acquisition, exploration, and model development by clarifying who is involved, what needs to be solved, where, and why.

52. **Assertion (A)** : Data acquisition is the foundation of a reliable AI model.

**Reason (R)** : Acquiring high-quality, relevant data ensures that the training and testing phases produce valid and generalizable results.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
Both statements are true, and the reason explains that without reliable data, the model's performance will suffer. High-quality data is crucial to learning correct patterns and achieving accurate predictions.

53. **Assertion (A)** : Data exploration helps uncover hidden insights and patterns within a dataset.

**Reason (R)** : Visualizing data with graphs and charts can reveal trends, outliers, and correlations that are not immediately obvious from raw data.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
Both statements are correct, and the reason accurately explains that visualization is key to understanding data structure and variability. This informs subsequent modelling decisions and helps improve model performance.

54. **Assertion (A)** : Linear regression is a common approach for prediction in AI modelling.

**Reason (R)** : Linear regression models the relationship between variables by fitting a straight line to the data.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

recall) provides a more comprehensive assessment of model performance and helps identify different aspects of errors.

## THREE MARKS QUESTIONS

- 96.** Discuss the importance of problem scoping in an AI project.

**Ans :** MAIN 2024

Problem scoping ensures that the project addresses the right issues by clarifying objectives, scope, and affected stakeholders. It guides data collection, model selection, and evaluation, making it foundational for project success.

- 97.** Explain the role of the 4 Ws in defining a problem statement.

**Ans :** SQP 2018

The 4 Ws (Who, What, Where, Why) help to pinpoint the context and significance of a problem, ensuring that all key aspects are considered. This detailed understanding aids in forming a precise and actionable problem statement.

- 98.** Why is acquiring high-quality data critical for AI?

**Ans :** COMP 2011

High-quality data minimizes errors, reduces bias, and ensures that the model learns accurate patterns. Without reliable data, even the best algorithms may produce flawed or misleading predictions.

- 99.** Describe the difference between structured and unstructured data.

**Ans :** MAIN 2006

Structured data is organized in fixed formats like spreadsheets or databases, making it easy to query. Unstructured data includes text, images, or audio, which requires additional processing to extract useful features.

- 100.** What is the purpose of splitting data into training and testing sets?

**Ans :** SQP 2025

Splitting data allows the model to learn patterns from one portion (training set) and then be evaluated on another (testing set). This helps

measure the model's ability to generalize to new, unseen data.

- 101.** How do bar graphs and histograms differ in data visualization?

**Ans :** COMP 2016

Bar graphs are used to compare categorical data, while histograms display the frequency distribution of numerical data by grouping values into bins. Both are crucial for understanding different aspects of data.

- 102.** What is linear regression, and when is it used?

**Ans :** MAIN 2021

Linear regression is a method for predicting continuous outcomes by modeling the relationship between dependent and independent variables. It is used when the relationship between the variables is approximately linear.

- 103.** Explain the concept of a rule-based approach in AI.

**Ans :** SQP 2010

A rule-based approach uses predefined if-then conditions to make decisions. It is simple and deterministic but lacks the ability to adapt to new or unforeseen situations compared to learning-based methods.

- 104.** Describe the difference between supervised and unsupervised learning.

**Ans :** COMP 2014

Supervised learning requires labeled data to train models to predict outcomes, while unsupervised learning discovers patterns in unlabeled data. Supervised methods are used for prediction and classification; unsupervised methods are often used for clustering and dimensionality reduction.

- 105.** What are data features, and why are they important?

**Ans :** MAIN 2008

Data features are the measurable properties or characteristics of data points that serve as inputs for models. They are crucial because the quality and relevance of features directly influence the accuracy and performance of the AI model.

- 106.** Discuss the role of system maps in data acquisition.

**Ans :** SQP 2022

**70.** Consider the following statements about model evaluation in AI projects:

1. Evaluation involves assessing the performance of a model using metrics such as accuracy, precision, recall, and error rate.
  2. Model evaluation is conducted using the same dataset that was used for training the model.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.

The material explains that evaluation is performed using separate testing data to assess performance with various metrics. Statement 2 is incorrect because using the training dataset for evaluation can lead to overfitting and does not properly validate model performance.

## PICTURE BASED QUESTIONS

**71.** Observe the image depicting a team of professionals brainstorming with sticky notes under headings: “Who,” “What,” “Where,” and “Why.” What process are they engaged in?



- (a) Data Collection  
 (b) Problem Scoping  
 (c) Model Evaluation  
 (d) Data Visualization

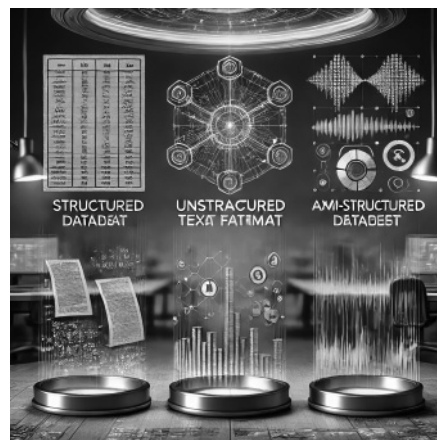
**Ans :**

(b) Problem Scoping

Problem scoping involves defining a problem clearly by identifying who is affected, what the

issue is, where it occurs, and why it matters. It helps in setting project objectives and ensuring a structured approach to solving problems.

An image shows a dataset containing different formats: tables, audio clips, text documents, and XML files. Which types of data are present?



- (a) Structured, Unstructured, and Semi-structured Data  
 (b) Only Structured Data  
 (c) Only Unstructured Data  
 (d) Only Semi-structured Data

**Ans :**

(a) Structured, Unstructured, and Semi-structured Data

Structured data is organized in tables, unstructured data includes images, text, and audio, and semi-structured data consists of formats like JSON or XML. AI models use different types of data for analysis and learning.

**73.** The image shows a bar graph comparing sales figures for different products and a scatter plot illustrating the correlation between study time and exam scores. What is the primary purpose of these visualizations?



A clear problem statement guides data collection and model design.

- 117.** A company needs to forecast sales for the next quarter. How should they approach data acquisition?

**Ans :**

They should gather historical sales data from reliable internal databases and external sources like market reports. Data features such as date, sales volume, and promotional events are crucial. Splitting data into training and testing sets ensures that the forecasting model is robust and reliable.

- 118.** An e-commerce platform wants to understand the behavior of its users. Describe how data exploration can help.

**Ans :**

Data exploration can involve creating histograms of purchase frequencies, scatter plots to observe correlations between browsing time and purchase amount, and line graphs to track trends over time. These visualizations uncover patterns that inform personalized marketing strategies.

- 119.** A real estate company intends to predict housing prices using AI. Which modelling approach should they consider and why?

**Ans :**

They should consider linear regression because it models the relationship between various predictors (square footage, location, etc.) and housing prices. It is well-suited for predicting continuous outcomes when the relationship is approximately linear. Evaluation on test data will confirm the model's effectiveness.

- 120.** A retail chain is considering a machine learning model to classify products for inventory management. How does supervised learning fit into this scenario?

**Ans :**

Supervised learning can be used by training a classifier on a labeled dataset (e.g., product images with their categories). The model learns to recognize features corresponding to each product type, enabling accurate categorization of new items and improved inventory control.

- 121.** An AI project on Kaggle requires a dataset for a sentiment analysis model. How should a data scientist proceed?

**Ans :**

The scientist should search Kaggle for relevant, well-curated datasets containing text reviews with sentiment labels. They must ensure the data quality and proper splitting into training and testing sets. Data exploration, such as word frequency analysis, will help understand text characteristics.

- 122.** A local government is developing a model to predict traffic congestion. Describe the data acquisition process.

**Ans :**

They should gather historical traffic data, sensor readings, weather conditions, and event information from reliable municipal sources and traffic APIs. Ensuring the dataset is comprehensive and representative of various conditions is key. Proper data preprocessing is then required before model training.

- 123.** A research lab wants to cluster research papers by topic without prior labeling. Which approach should they use?

**Ans :**

They should apply unsupervised learning techniques, such as clustering algorithms (e.g., K-means). This approach groups papers with similar textual features, allowing the lab to identify natural topic clusters without needing predefined categories.

- 124.** A manufacturing firm seeks to improve quality control using AI. They want to predict defects based on production data. Which modelling approach is most appropriate?

**Ans :**

Supervised learning, specifically classification techniques, would be most suitable. By training on historical production data with labels indicating defect types, the model can learn to predict defects in new production runs, helping to preempt quality issues.

- 125.** A startup developing a new app needs to assess user behavior trends. Explain how data exploration and visualization would help.

**Ans :**

# CHAPTER 9

## MODULES AND PACKAGES IN PYTHON

### SUMMARY

#### 1. MODULES

A module is a single file (with a .py extension) that contains Python code—functions, classes, and variables—that you can reuse in other programs. Example :A file named `math_utils.py` with helper functions.

#### 2. PACKAGES

A package is a collection of related modules organized in a directory. It contains an `__init__.py` file (which can be empty) to indicate that the directory is a package. Example : A package named `data_processing` containing modules like `cleaning.py`, `transform.py`.

#### 3. LIBRARIES

A library is a collection of packages and modules designed to provide a wide range of functionalities. It offers pre-written code for complex tasks. Examples in Python :

1. NumPy : For numerical operations, handling arrays, linear algebra.
2. Pandas : For data manipulation and analysis using DataFrames.
3. SciPy : For scientific and technical computing (e.g., optimization, integration).
4. Matplotlib : For creating static, animated, and interactive visualizations.

#### 4. WHY WE NEED LIBRARIES

##### 4.1 Reusability

Libraries allow you to reuse code written by experts rather than reinventing the wheel.

##### 4.2 Efficiency

They provide optimized and tested implementations of complex functions.

##### 4.3 Ease of Use

With libraries, you can quickly perform data manipulations, numerical calculations, and visualizations without writing low-level code.

##### 4.4 Community and Support

Popular libraries are well documented and supported by a large community.

#### 5. SYNTAX FOR IMPORTING LIBRARIES AND SIMPLE PROGRAMS

##### 5.1 Basic Import Syntax

1. To import an entire module :  

```
import math
```
2. To import a module with an alias (commonly used for libraries)  

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```
3. To import specific functions or classes :  

```
from math import sqrt
from pandas import DataFrame
```

#### 6. SIMPLE EXAMPLE PROGRAMS

##### 6.1 Using NumPy to Create an Array

```
import numpy as np
arr = np.array([1, 2, 3, 4, 5])
print("Array :", arr)
```

##### 6.2 Creating a DataFrame with Pandas

```
import pandas as pd
data = {'Name' : ['Alice', 'Bob'],
 'Age' : [25, 30]}
df = pd.DataFrame(data)
print(df)
```

##### 6.3 Plotting a Simple Line Graph with Matplotlib

```
import matplotlib.pyplot as plt
x = [0, 1, 2, 3, 4]
y = [0, 1, 4, 9, 16]
```

They should use metrics such as accuracy, precision, recall, and error rate to evaluate performance.

These metrics provide a comprehensive view of how well the model distinguishes between spam and non-spam, helping to identify potential areas for improvement.

- 133.** How would you formulate a clear and concise problem statement for a project aimed at reducing misclassification in a fruit sorting system?

**Ans :**

The problem statement should state the objective (e.g., “Improve fruit sorting accuracy”), define the scope (e.g., “in our packaging line”), and mention any limitations (e.g., “using existing sensor data”).

A well-crafted problem statement aligns team efforts and sets measurable goals for the project.

- 134.** Why are system maps useful in AI projects, and how can they be applied during the data acquisition and exploration phases?

**Ans :**

System maps provide visual diagrams of data flows and relationships among system components, highlighting integration points and potential bottlenecks.

They serve as a blueprint that facilitates clearer communication among stakeholders and better planning during both data acquisition and exploration.

- 135.** During data acquisition from multiple sources, what challenges might arise, and how can these be mitigated to ensure high-quality data for modelling?

**Ans :**

Challenges include inconsistent data formats, missing values, and varying data quality.

These issues can be mitigated through rigorous data cleaning, preprocessing, and validation against trusted sources.

Addressing these challenges early in the process ensures that the subsequent model is built on reliable, high-quality data, leading to more accurate outcomes.

a robust development environment and enhancing productivity substantially, thus promoting efficient software creation.

- 35.** A programmer writes the statement ``import numpy as np`` at the beginning of a script to perform numerical calculations.

What does the alias `np` represent in this context?

- (a) A package name
- (b) An alias for NumPy
- (c) A module within NumPy
- (d) A separate library

**Ans :**

SQP 2011

- (b) An alias for NumPy

Using the syntax ``import numpy as np`` creates an alias, allowing the programmer to refer to NumPy with the shorthand “`np`”. This practice improves code readability and reduces effort. The alias does not change functionality, serving as a convenient nickname for the full library name, ensuring concise code usage effectively.

- 36.** A data scientist writes ``from math import sqrt`` in a Python script to compute square roots without referencing the module each time.

What does this statement do?

- (a) Imports the entire math module
- (b) Imports only the `sqrt` function from `math`
- (c) Renames `sqrt` to `math.sqrt`
- (d) Imports `math` and renames it to `sqrt`

**Ans :**

COMP 2009

- (b) Imports only the `sqrt` function from `math`

The statement ``from math import sqrt`` imports only the `sqrt` function from the `math` module directly into the namespace. This allows the programmer to call `sqrt()` without referencing the module name, improving code clarity and efficiency. It minimizes unnecessary imports, keeping the namespace clean and focused on required functionality effectively.

- 37.** A programmer writes the code below to perform numerical operations :

```
```python
import numpy as np
arr = np.array([1, 2, 3, 4, 5])
```
```

What is achieved by this code?

- (a) Creating a list
- (b) Performing numerical integration
- (c) Creating a NumPy array
- (d) Plotting data

**Ans :**

MAIN 2007

- (c) Creating a NumPy array

The code uses NumPy to create an array, a fundamental data structure for numerical computations in Python. By calling `np.array()` with a list, the programmer converts the list into a NumPy array, enabling efficient mathematical operations and data manipulation. This approach leverages NumPy's optimized performance for scientific computing tasks effectively.

- 38.** A data analyst writes the following code to organize tabular data :

```
```python
import pandas as pd
data = {'Name': ['Alice', 'Bob'], 'Age': [25, 30]}
df = pd.DataFrame(data)
```
```

What does this code do?

- (a) Creates a NumPy array
- (b) Creates a DataFrame
- (c) Plots data
- (d) Performs integration

**Ans :**

SQP 2010

- (b) Creates a DataFrame

The code imports Pandas, creates a dictionary containing data, and then converts it into a DataFrame using `pd.DataFrame()`. DataFrames are two-dimensional labeled data structures ideal for data manipulation and analysis. This code transforms raw data into a structured format, facilitating efficient data processing and visualization tasks in Python environments.

- 39.** A developer writes a Python script using Matplotlib to plot the lists :

```
```python
x = [0, 1, 2, 3, 4]
y = [0, 1, 4, 9, 16]
```
```

and adds labels and a title.

What is the purpose of this script?

- (a) Creating a DataFrame
- (b) Numerical integration
- (c) Visualizing a line graph
- (d) Data cleaning

**Ans :**

COMP 2008

- (c) Visualizing a line graph

The script uses Matplotlib to plot a line graph that visualizes the relationship between given `x` and `y` values. By setting axis labels and a title, the developer creates an informative plot. This

```
plt.plot(x, y)
plt.xlabel('X-axis')
plt.ylabel('Y-axis')
plt.title('Line Graph Example')
plt.show()
```

#### 6.4 Performing Numerical Integration with SciPy

```
from scipy import integrate
result, error = integrate.quad(lambda
x : x2, 0, 1)
print("Integral of x2 from 0 to 1
: ", result)
```

### MULTIPLE CHOICE QUESTION

- What is a Python module?
  - A compiled binary file
  - A file containing Python code (functions, classes, etc.)
  - A visual tool for plotting graphs
  - A hardware component

Ans : MAIN 2025

(b) A file containing Python code (functions, classes, etc.)

A module is a single Python file (with a .py extension) that contains code (functions, classes, variables) that you can import and use in other programs, promoting code reuse and organization.

- What defines a Python package?
  - A single module file
  - A collection of modules in a directory with an `__init__.py` file
  - A compiled program
  - A graphical user interface

Ans : SQP 2021

(b) A collection of modules in a directory with an `__init__.py` file

A package is a directory that contains multiple Python modules along with an `__init__.py` file to indicate that it is a package, enabling better organization and management of related modules.

- Which term best describes NumPy, Pandas, SciPy, and Matplotlib?
  - Operating systems
  - Libraries
  - IDEs
  - Web frameworks

Ans :

COMP 2023

(b) Libraries

These are libraries—a collection of packages and modules—designed to provide specialized functionalities such as numerical operations (NumPy), data manipulation (Pandas), scientific computing (SciPy), and visualization (Matplotlib).

- What is the primary purpose of NumPy?
  - Data visualization
  - Numerical and array computations
  - Building web applications
  - Natural language processing

Ans :

MAIN 2013

(b) Numerical and array computations

NumPy is primarily used for numerical operations and handling multidimensional arrays, providing efficient computations and mathematical functions to support data analysis and scientific computing.

- Pandas is best known for which capability?
  - Creating interactive plots
  - Data manipulation and analysis using DataFrames
  - Performing symbolic mathematics
  - Handling network protocols

Ans :

SQP 2016

(b) Data manipulation and analysis using DataFrames

Pandas provides high-level data structures like DataFrames and Series, making it a powerful library for data manipulation, cleaning, and analysis, which is essential for preparing data for AI and machine learning.

- Which library is primarily used for scientific computing tasks like optimization?
  - Matplotlib
  - SciPy
  - Pandas
  - Seaborn

Ans :

COMP 2015

(b) SciPy

SciPy builds on NumPy and provides additional functions for optimization, integration, interpolation, and other scientific computations, making it ideal for complex numerical tasks in scientific research.

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**Ans :**

MAIN 2013

(a) It renames the Pandas library to pd for ease of use

Using import pandas as pd allows you to refer to the Pandas library with the shorter alias pd, which simplifies your code and makes it more readable.

**23.** Which of the following is not a benefit of using Python libraries?

- (a) Rapid development using pre-built functions
- (b) Reliable, tested implementations of algorithms
- (c) Eliminating the need for coding entirely
- (d) Enhanced productivity through code reuse

**Ans :**

SQP 2015

(c) Eliminating the need for coding entirely  
Libraries simplify and speed up development by providing pre-written, tested code. However, they do not eliminate the need for programming—they assist the developer by handling common tasks, but coding is still required to build applications.

**24.** How can you import multiple functions from a module in one statement?

- (a) import math, sqrt
- (b) from math import sqrt, sin, cos
- (c) import sqrt, sin, cos from math
- (d) from math import

**Ans :**

COMP 2006

(b) from math import sqrt, sin, cos  
The syntax from math import sqrt, sin, cos allows you to import several specific functions from the math module. Option D imports everything, but option B is more precise and is the correct method for importing multiple named functions.

**25.** Which of the following libraries is not typically used for data analysis?

- (a) Pandas
- (b) NumPy
- (c) Matplotlib
- (d) Django

**Ans :**

MAIN 2018

(d) Django  
Django is a web framework used for building web applications, not for data analysis. Pandas, NumPy, and Matplotlib are standard libraries for data manipulation, numerical computations, and data visualization.

**26.** Which statement best explains the need for libraries in Python?

- (a) They provide unnecessary redundancy
- (b) They offer pre-built, optimized code that saves development time
- (c) They slow down the execution
- (d) They are only used for learning purposes

**Ans :**

SQP 2009

(b) They offer pre-built, optimized code that saves development time

Libraries provide robust, optimized, and well-tested functions, allowing developers to focus on application logic rather than reimplementing common functionalities, thereby significantly speeding up development and reducing errors.

**27.** What is the output of the following code snippet?  
python

```
import numpy as np
a = np.array([1, 2, 3])
print(a.shape)
```

- (a) (3,)
- (b) (1, 3)
- (c) 3
- (d) (3, 3)

**Ans :**

COMP 2007

(a) (3,)   
The NumPy array a is a one-dimensional array with 3 elements, so its shape is represented as (3,), indicating one axis with a length of 3.

**28.** Which library would you use for plotting a histogram in Python?

- (a) SciPy
- (b) Matplotlib
- (c) NumPy
- (d) Pandas

**Ans :**

MAIN 2010

(b) Matplotlib  
Matplotlib is widely used for creating various types of plots, including histograms. While Pandas can also plot data, it internally uses Matplotlib for rendering graphs.

**29.** What is the function of the \_\_init\_\_.py file in a package?

- (a) It runs the package automatically
- (b) It marks the directory as a Python package
- (c) It initializes all variables
- (d) It compiles the package

**Ans :**

SQP 2022

(b) It marks the directory as a Python package

NumPy is designed for efficient numerical computations and is the backbone for many advanced mathematical operations in Python.

15. How does Pandas improve data handling?
- It creates images automatically
  - It provides DataFrames for efficient tabular data manipulation
  - It compiles code faster
  - It only stores text data

Ans :

COMP 2022

(b) It provides DataFrames for efficient tabular data manipulation

Pandas introduces DataFrames—a powerful data structure for handling, cleaning, and analyzing tabular data. This enables more efficient data manipulation compared to traditional lists or dictionaries.

16. What does the function `np.array()` do?
- Creates a new list
  - Converts input data into a NumPy array
  - Plots a graph
  - Imports a library

Ans :

MAIN 2024

(b) Converts input data into a NumPy array  
The `np.array()` function converts the given input (such as a list) into a NumPy array, which supports advanced mathematical operations and efficient storage.

17. How do you display a plot in Matplotlib?
- `plt.show()`
  - `plt.display()`
  - `plt.plot()`
  - `plt.open()`

Ans :

SQP 2019

(a) `plt.show()`

After setting up a plot with Matplotlib, calling `plt.show()` opens a window displaying the graph. This is the standard method for rendering visualizations.

18. Which library is used for performing integration in Python?
- NumPy
  - SciPy
  - Pandas
  - Matplotlib

Ans :

COMP 2011

(b) SciPy

SciPy provides functions for scientific computations, including integration. The function `integrate.quad()` is an example used to compute definite integrals.

19. What is the advantage of using aliases (e.g., `np`, `pd`) when importing libraries?
- They shorten the code and improve readability
  - They increase memory usage
  - They prevent errors in the code
  - They are required by the Python interpreter

Ans :

MAIN 2009

(a) They shorten the code and improve readability  
Aliases shorten long library names, making code cleaner and easier to read. They do not affect memory usage or error prevention, but they enhance code clarity and consistency.

20. Which command imports only the `sqrt` function from the `math` module?
- `import math.sqrt`
  - `from math import sqrt`
  - `import sqrt from math`
  - `from sqrt import math`

Ans :

SQP 2025

(b) `from math import sqrt`

The syntax `from math import sqrt` imports only the `sqrt` function from the `math` module, allowing you to call `sqrt()` directly without prefixing it with `math..`

21. Which statement best describes a Python library?
- A single Python file
  - A collection of modules and packages that offer specific functionalities
  - An operating system
  - A type of hardware

Ans :

COMP 2023

(b) A collection of modules and packages that offer specific functionalities

A library is a collection of related modules and packages that provide pre-written code to perform specialized tasks, such as numerical computations or data analysis.

22. What does the statement `import pandas as pd` achieve?
- It renames the Pandas library to `pd` for ease of use
  - It deletes the Pandas library
  - It compiles Pandas code
  - It creates a new module

They can use scatter plots to identify correlations between usage time and feature engagement, histograms to analyze frequency distributions of user sessions, and line graphs to observe trends over time. These visual insights enable the startup to tailor the app experience to user preferences and improve retention.

- 126.** A manufacturing team is tasked with improving fruit sorting accuracy on their packaging line. How should they approach problem scoping using the 4 Ws?

**Ans :**

They should identify:

1. Who: Stakeholders like production workers and quality control inspectors,
  2. What: The specific issue of misclassification during sorting,
  3. Where: On the fruit packaging line, and
  4. Why: To reduce waste and improve efficiency.
- This structured approach ensures that all factors are considered and the project's goals are clearly defined.

- 127.** A data scientist needs to build an AI model to classify customer feedback. What types of data should be considered, and where can reliable data be obtained?

**Ans :**

They should consider:

1. Structured data (e.g., survey responses in databases),
2. Unstructured data (e.g., free text reviews), and
3. Semi-structured data (e.g., JSON data from online forms).

Data can be sourced from internal surveys, public repositories, or platforms like Kaggle.

Using multiple types of data from validated sources ensures a comprehensive dataset for robust model training.

- 128.** In a project aiming to enhance fruit sorting accuracy, what data features are critical to capture, and how should these features be sourced?

**Ans :**

Critical features might include attributes such as color, size, weight, and texture.

These features can be sourced from sensors on the packaging line and supplemented with high-quality datasets from platforms like Kaggle.

Accurate feature selection and sourcing directly impact the model's ability to identify and reduce sorting errors.

- 129.** Why is it important to split data into training and testing sets, and how does this benefit model evaluation?

**Ans :**

Splitting data ensures the model is trained on one subset (training data) and evaluated on a separate subset (testing data), which prevents overfitting and gives a realistic performance estimate.

This separation enables developers to assess how well the model generalizes to new, unseen data, ensuring its reliability in real-world applications.

- 130.** A data analyst needs to uncover trends, outliers, and correlations in a sales dataset. Which visualization tools and graphs should they use, and why?

**Ans :**

They should use:

1. Bar graphs or histograms to display frequency distributions,
2. Line graphs to observe trends over time,
3. Scatter plots to reveal correlations, and
4. Pie charts to illustrate proportional distributions.

These visualizations help extract meaningful insights that guide further data cleaning and model selection.

- 131.** When developing an AI model to predict sales, what modelling approach is most suitable for continuous outcomes, and what alternative approaches could be considered?

**Ans :**

They should consider a prediction approach using linear regression for continuous outcomes, while also exploring supervised learning methods if additional features and nonlinear relationships are present.

Selecting the correct model approach ensures that predictions are as accurate and relevant as possible for the business needs.

- 132.** A team develops a classifier for spam detection in emails. What evaluation metrics should they use to assess the model's performance, and why are these metrics important?

**Ans :**

The presence of an `__init__.py` file in a directory signals to Python that the directory should be treated as a package. It may also include initialization code for the package, but its primary role is to mark the directory as a package.

30. What does the following code do?

```
python
from pandas import DataFrame
data = {'A': [1, 2], 'B': [3, 4]}
df = DataFrame(data)
print(df)
```

- (a) It creates a NumPy array
- (b) It creates a Pandas DataFrame and prints it
- (c) It plots a graph
- (d) It fails to run

Ans :

COMP 2021

(b) It creates a Pandas DataFrame and prints it  
This code imports the DataFrame class from Pandas, creates a dictionary of data, and converts it into a DataFrame. The DataFrame is then printed, displaying the tabular data. It demonstrates how to use Pandas for data manipulation.

31. A developer creates a file named `math_utils.py` containing helper functions for mathematical computations.

What is `math_utils.py` considered?

- (a) Package
- (b) Library
- (c) Module
- (d) Framework

Ans :

MAIN 2024

(c) Module  
A module is a single Python file with a `.py` extension containing functions, classes, and variables for reuse in other programs. In this case, `math_utils.py` serves as a module, encapsulating helper functions and code. Its modular structure facilitates code reusability, organization, and ease of maintenance across multiple projects, effectively implemented.

32. A programmer organizes several files—`cleaning.py` and `transform.py`—inside a directory called `data_processing` that also contains an `__init__.py` file.

What does this directory represent?

- (a) Module
- (b) Package
- (c) Library

- (d) Framework

Ans :

SQP 2016

- (b) Package

A package is a collection of related modules organized within a directory that includes an `__init__.py` file. In this case, the `data_processing` directory containing `cleaning.py` and `transform.py` represents a package. It enables logical organization, simplifies code management, and enhances reusability across projects, promoting remarkably efficient and scalable software development.

33. A developer needs to perform numerical operations, data manipulation, and create visualizations. They decide to use NumPy, Pandas, and Matplotlib in their project.

What best describes these resources?

- (a) Modules
- (b) Packages
- (c) Libraries
- (d) Frameworks

Ans :

COMP 2019

- (c) Libraries

A library is a collection of packages and modules that provide a wide range of functionalities. In this scenario, NumPy, Pandas, and Matplotlib are libraries designed for numerical operations, data manipulation, and visualizations. They offer code, allowing developers to perform complex tasks efficiently without reinventing the wheel, promoting productivity effectively.

34. A new Python developer decides to use pre-existing libraries rather than writing all functions from scratch for their project.

Why are libraries important in development?

- (a) They slow down development
- (b) They offer reusability, efficiency, and community support
- (c) They limit functionality
- (d) They are outdated

Ans :

MAIN 2012

- (b) They offer reusability, efficiency, and community support

Libraries provide pre-written, tested, and optimized code, ensuring reusability and efficiency. In this case, the developer leverages libraries to avoid reinventing complex functions, saving time and effort. Additionally, large community support and documentation help resolve issues, fostering

7. Which library is commonly used for plotting graphs in Python?

(a) NumPy  
(b) SciPy  
(c) Matplotlib  
(d) Pandas

Ans :

MAIN 2006

(c) Matplotlib

Matplotlib is the most widely used Python library for creating static, interactive, and animated visualizations, allowing users to create plots, histograms, bar charts, and more.

8. How do you import NumPy with an alias?

(a) import numpy as np  
(b) import numpy as pd  
(c) import np  
(d) from numpy import

Ans :

SQP 2012

(a) import numpy as np

The common convention is to import NumPy with the alias np using the syntax import numpy as np, making it easier to reference its functions in code.

9. Which syntax correctly imports the Pandas library with an alias?

(a) import pandas as pd  
(b) import pandas as np  
(c) from pandas import pd  
(d) import pd

Ans :

COMP 2018

(a) import pandas as pd

The standard convention for importing Pandas is import pandas as pd, which allows you to reference Pandas functions and objects using the shorter alias pd.

10. What does the statement from matplotlib import pyplot as plt do?

(a) It imports the entire Matplotlib library  
(b) It imports the pyplot module from Matplotlib and assigns it the alias plt  
(c) It creates a new plotting library  
(d) It compiles Matplotlib code

Ans :

MAIN 2014

(b) It imports the pyplot module from Matplotlib and assigns it the alias plt

This statement imports the pyplot module from the Matplotlib library, which is used for plotting,

and assigns it the alias plt for convenient access to its functions.

11. Which file extension indicates a Python module?

(a) .txt  
(b) .py  
(c) .docx  
(d) .exe

Ans :

SQP 2007

(b).py

Python modules are saved with the .py extension. These files contain Python code and can be imported into other Python programs to reuse functions, classes, and variables.

12. What is the purpose of an \_\_init\_\_.py file in a package?

(a) To run the package automatically  
(b) To mark a directory as a Python package  
(c) To store data  
(d) To compile modules

Ans :

COMP 2017

(b) To mark a directory as a Python package

The presence of an \_\_init\_\_.py file in a directory signals to Python that the directory should be treated as a package, allowing modules within it to be imported as part of that package.

13. Why are libraries important in Python programming?

(a) They provide pre-written code to perform common tasks efficiently  
(b) They slow down development  
(c) They are only used for web development  
(d) They are optional and rarely used

Ans :

MAIN 2010

(a) They provide pre-written code to perform common tasks efficiently

Libraries save time by offering reusable, optimized, and well-tested code for common tasks. They allow developers to focus on solving specific problems without needing to write all code from scratch.

14. Which library is most appropriate for performing advanced mathematical computations?

(a) NumPy  
(b) Matplotlib  
(c) Pandas  
(d) Seaborn

Ans :

SQP 2008

(a) NumPy

visual representation helps interpret data trends and patterns, making it easier to analyze and communicate insights effectively.

40. A scientist performs numerical integration of the function  $x^2$  from 0 to 1 using the code :

```
```python
from scipy import integrate
result, error = integrate.quad(lambda x : x2, 0, 1)
```
```

What is achieved by this code?

- (a) Array creation
- (b) DataFrame generation
- (c) Numerical integration
- (d) Data visualization

Ans :

MAIN 2022

- (c) Numerical integration

The code uses SciPy's `integrate.quad()` function to numerically integrate the function  $x^2$  between 0 and 1. This process computes the area under the curve, yielding both the result and an error estimate. Numerical integration is essential for approximating integrals that lack analytical solutions, enabling practical scientific computations with precision.

41. Which statement best describes the purpose of modules and packages in Python?

- (a) They allow for code reusability and better organization of functions and classes.
- (b) They are used solely for creating graphical interfaces.
- (c) They compile Python code into binary files.
- (d) They automatically generate machine learning models.

Ans :

SQP 2006

- (a) They allow for code reusability and better organization of functions and classes.

Modules and packages enable developers to organize code into reusable components. This structure promotes maintainability and clarity by separating functions and classes into logical files and directories.

42. Which statement correctly describes NumPy?

- (a) It is a library used exclusively for data visualization.
- (b) It provides support for large, multi-dimensional arrays and mathematical functions.
- (c) It is a tool for web development.
- (d) It only works with Python 2.x.

Ans :

COMP 2012

- (b) It provides support for large, multi-dimensional arrays and mathematical functions.

NumPy is essential for numerical computing, offering efficient operations on arrays and matrices, as well as a wide range of mathematical functions.

43. Which statement best describes Pandas?

- (a) It is used for web scraping.
- (b) It provides data structures like DataFrames for easy data manipulation and analysis.
- (c) It is a visualization library.
- (d) It is used for low-level networking.

Ans :

MAIN 2018

- (b) It provides data structures like DataFrames for easy data manipulation and analysis.

Pandas introduces DataFrames, which are highly efficient for handling, cleaning, and analyzing tabular data, making it a cornerstone of data analysis in Python.

44. Which statement best explains the use of Matplotlib?

- (a) It is used for processing large datasets.
- (b) It is used for scientific computations exclusively.
- (c) It is a library for creating a wide variety of static, animated, and interactive visualizations.
- (d) It is used to build machine learning models.

Ans :

SQP 2024

- (c) It is a library for creating a wide variety of static, animated, and interactive visualizations. Matplotlib is a powerful library for plotting and visualizing data in various formats, such as line graphs, bar charts, scatter plots, and more.

45. Which statement correctly explains the syntax for importing a module in Python?

- (a) `import module_name as alias` is used to import a module with a shorter name.
- (b) `from module import` compiles the module.
- (c) `import module_name` only works in interactive mode.
- (d) `module_name.import()` is the correct syntax.

Ans :

COMP 2007

- (a) `import module_name as alias` is used to import a module with a shorter name.

Using the alias syntax (e.g., `import numpy as np`) simplifies code and improves readability by allowing you to refer to the module with a shorter name.

tasks. Matplotlib is a widely used library for creating visualizations such as graphs and charts.

## TWO MARKS QUESTIONS

**76.** Define a Python module.

**Ans :**

MAIN 2010

A module is a single file containing Python code, including functions, classes, and variables, that can be imported into other Python programs.

**77.** What is a Python package?

**Ans :**

COMP 2019

A package is a directory of related Python modules that includes an `__init__.py` file to indicate it is a package.

**78.** Define a Python library.

**Ans :**

SQP 2020

A library is a collection of packages and modules that provide reusable code for various functionalities, such as data analysis and visualization.

**79.** What is the purpose of NumPy?

**Ans :**

COMP 2013

NumPy provides support for large, multi-dimensional arrays and matrices, along with mathematical functions to perform numerical computations efficiently.

**80.** What is the primary use of Pandas?

**Ans :**

MAIN 2011

Pandas is used for data manipulation and analysis through its powerful data structures like DataFrames, enabling efficient handling of tabular data.

**81.** How does SciPy extend the capabilities of NumPy?

**Ans :**

SQP 2022

SciPy adds modules for advanced scientific computing tasks, including optimization, integration, and signal processing, building upon NumPy's array functionalities.

**82.** What is Matplotlib used for?

**Ans :**

COMP 2015

Matplotlib is a plotting library for creating static, interactive, and animated visualizations in Python.

**83.** Write the syntax to import NumPy with an alias.

**Ans :**

MAIN 2006

`import numpy as np`

**84.** How would you import only the DataFrame class from Pandas?

**Ans :**

SQP 2025

`from pandas import DataFrame`

**85.** What file extension do Python modules have?

**Ans :**

COMP 2021

Python modules have a `.py` extension.

**86.** What is the role of the `__init__.py` file in a package?

**Ans :**

MAIN 2023

It marks the directory as a Python package and can include initialization code for the package.

**87.** Why are libraries important in programming?

**Ans :**

SQP 2022

They provide pre-built, optimized code that saves time and reduces errors by allowing developers to reuse well-tested functions.

**88.** What is a DataFrame in Pandas?

**Ans :**

COMP 2017

A DataFrame is a two-dimensional, size-mutable, and heterogeneous tabular data structure with labeled axes.

**89.** Describe a simple use case for Matplotlib.

**Ans :**

MAIN 2025

Matplotlib can be used to create a line graph that visualizes trends in data over time.

**90.** What does the `np.array()` function do?

**Ans :**

SQP 2021

It converts a list or other sequence into a NumPy array for numerical operations.

**91.** How do you import a module with an alias?

**Ans :**

COMP 2023

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Both statements are true, and the reason correctly explains why a clear problem statement is essential. It guides the entire project by establishing what needs to be addressed and clarifying the scope.

**52. Assertion (A) :** High-quality data acquisition is foundational for building effective AI models.

**Reason (R) :** Reliable and relevant data minimizes errors and biases during model training and evaluation.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both the assertion and reason are correct, and the reason explains that quality data is essential for accurate learning and generalization. Without it, even sophisticated models may yield poor performance.

**53. Assertion (A) :** Data exploration is crucial for understanding the underlying patterns of a dataset.

**Reason (R) :** Visualizing data using graphs like histograms and scatter plots reveals trends and anomalies that guide model selection.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are true, and the reason correctly explains the purpose of data exploration. Visualization helps uncover important patterns and potential issues, which is key to making informed modelling decisions.

**54. Assertion (A) :** Linear regression is commonly used for predicting continuous outcomes in AI.

**Reason (R) :** It models the linear relationship between independent and dependent variables by fitting a straight line to the data.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are correct, and the reason accurately explains the mechanism behind linear regression. It shows how the method predicts outcomes based on the best-fit line through the data points.

**55. Assertion (A) :** Supervised learning relies on labeled data for training.

**Reason (R) :** Labeled data provides the correct outputs that the model learns to predict, ensuring the mapping between inputs and outputs.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are true, and the reason explains why supervised learning requires labels. The labels serve as the ground truth, guiding the model during training and making accurate predictions.

**56. Assertion (A) :** Unsupervised learning is used to discover patterns in data without pre-assigned labels.

**Reason (R) :** Unsupervised algorithms group similar data points or reduce dimensions to reveal hidden structures.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are true, and the reason correctly explains the function of unsupervised learning. These algorithms identify inherent patterns without the need for external labels, making them ideal for exploratory analysis.

**57. Assertion (A) :** Acquiring data from reliable sources is essential for accurate AI models.

**Reason (R) :** High-quality data minimizes the propagation of errors and biases throughout the model development process.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are true, and the reason explains that reliable data is fundamental to model accuracy. Poor-quality data can lead to significant errors and skewed predictions, underlining the need for trustworthy sources.

**58. Assertion (A) :** Bar graphs and histograms are effective visualization tools in data exploration.

**Reason (R) :** They display the distribution and frequency of data, which helps identify trends and outliers.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are correct, and the reason accurately explains why these visualization tools are useful. They allow analysts to quickly assess the distribution and variability of data, guiding further analysis.

**59. Assertion (A) :** Rule-based approaches in AI are less flexible than learning-based approaches.

**Reason (R) :** Rule-based systems follow fixed if-then conditions and cannot adapt when new data emerges.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both statements are true, and the reason explains that rule-based systems are inherently static. They lack the adaptability of learning-based methods, which update their models with new data.

**Assertion (A) :** The Kaggle platform is a valuable resource for AI datasets.

**Reason (R) :** It offers a wide variety of curated datasets and competitions that promote learning and benchmarking.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both statements are true, and the reason correctly explains Kaggle's value. It provides access to high-quality data and competitive challenges that drive innovation and learning in the AI community.

## STATEMENT BASED QUESTIONS

**61.** Consider the following statements about Python modules :

1. A module is a single file with a `.py` extension that contains Python code (functions, classes, and variables).
  2. A module must include an `__init__.py` file to be recognized by Python.
- (a) Only statement 1 is correct.
  - (b) Only statement 2 is correct.
  - (c) Both statements 1 and 2 are correct.
  - (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.

A module is indeed a single `.py` file containing code. The `__init__.py` file is required for a directory to be recognized as a package, not for a module.

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**62.** Consider the following statements about Python packages :

1. A package is a collection of related modules organized in a directory.
  2. A package must include an `__init__.py` file to indicate that the directory is a package.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

A package is defined as a collection of modules in a directory, and the presence of an `__init__.py` file (which may be empty) signals to Python that the directory should be treated as a package.

**63.** Consider the following statements about Python libraries :

1. A library is a collection of packages and modules designed to provide a wide range of functionalities.
  2. Libraries contain only modules and do not include any packages.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.

A library is indeed a collection of packages and modules that offer a variety of functions. Statement 2 is incorrect because libraries can include both packages and modules.

**64.** Consider the following statements about the benefits of using libraries :

1. Libraries allow you to reuse code written by experts, which prevents you from reinventing the wheel.
  2. Libraries are generally slower than custom code because they are not optimized.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.

Libraries promote code reuse and efficiency by providing optimized, pre-written code. Statement 2 is false; libraries are typically highly optimized and tested for performance.

**65.** Consider the following statements about basic import syntax in Python :

1. To import an entire module, you use the syntax `import module_name`.
  2. To import a module with an alias, you use the syntax `import module_name as alias`.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

The provided syntax is accurate : `import module_name` imports the module, and `import module_name as alias` allows you to use a shorter or more convenient alias.

**66.** Consider the following statements about importing specific components from a module :

1. The syntax `from math import sqrt` imports only the `sqrt` function from the `math` module.
  2. The syntax `from pandas import DataFrame` imports only the `DataFrame` class from the `pandas` module.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

Both import statements are used to import specific components (a function or class) from their respective modules without importing the entire module.

**67.** Consider the following statements about NumPy :

1. NumPy is a library designed for numerical operations, including handling arrays and performing linear algebra.
  2. After importing NumPy with an alias (e.g., `import numpy as np`), you can create an array using `np.array([1, 2, 3, 4, 5])`.
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

NumPy is specifically designed for numerical operations, and using the alias `np`, you can

**Ans :**

COMP 2015

A DataFrame is a two-dimensional, tabular data structure with labeled axes that supports vectorized operations and complex data manipulation, whereas a dictionary is an unordered collection of key-value pairs without built-in methods for data analysis.

- 104.** What is the significance of the `__init__.py` file in a package?

**Ans :**

SQP 2018

The `__init__.py` file signals to Python that a directory should be treated as a package, allowing for the structured organization and import of modules. It may also initialize package-level variables or setup configurations.

- 105.** How does importing specific functions (e.g., from `math import sqrt`) benefit your code?

**Ans :**

COMP 2007

Importing specific functions reduces namespace clutter, allowing you to use the function directly without the module prefix, which can simplify code and improve readability.

- 106.** Discuss a simple scenario where NumPy can significantly speed up computations compared to native Python.

**Ans :**

MAIN 2014

When performing element-wise operations on large arrays (e.g., adding two arrays of a million elements), NumPy's vectorized operations are implemented in C and are much faster than looping through Python lists.

- 107.** How can you use Matplotlib to identify trends in a dataset?

**Ans :**

SQP 2012

By plotting a line graph or scatter plot, you can visually examine the data points and observe patterns, trends, or anomalies. These visual insights help in understanding the behavior of variables over time or across conditions.

- 108.** What is the main advantage of using Pandas for handling CSV data?

**Ans :**

COMP 2019

Pandas can quickly read, manipulate, and analyze CSV files using DataFrames, allowing for easy data cleaning, filtering, and statistical analysis, which streamlines the data processing pipeline.

- 109.** Why is it necessary to preprocess data before feeding it into a machine learning model?

**Ans :**

MAIN 2025

Preprocessing cleans and normalizes data, removes noise and outliers, and transforms data into a suitable format. This ensures the model learns accurately and performs reliably on unseen data.

- 110.** How does the rule-based approach in AI differ from a learning-based approach?

**Ans :**

SQP 2021

The rule-based approach uses fixed if-then rules defined by experts, while the learning-based approach allows the system to learn patterns from data and adjust its behavior automatically, providing greater adaptability.

- 111.** Explain how the syntax `import matplotlib.pyplot as plt` enhances code clarity.

**Ans :**

COMP 2023

This syntax assigns a short alias (`plt`) to the `pyplot` module, making subsequent function calls (e.g., `plt.plot()`, `plt.show()`) more concise and readable. It's a standard convention that enhances consistency across Python projects.

- 112.** What might be a drawback of using `from module import *`?

**Ans :**

MAIN 2024

It imports all names from the module into the current namespace, which can lead to name clashes and reduced code clarity, making it harder to determine which functions or variables come from which module.

- 113.** How can libraries like Pandas and NumPy contribute to efficient data processing?

**Ans :**

SQP 2013

They offer optimized data structures and vectorized operations that perform computations much faster than native Python loops, which is especially beneficial when dealing with large datasets.

- 114.** Explain the role of a package in organizing Python code.

**Ans :**

COMP 2016

A package groups related modules into a single directory, providing a hierarchical structure that

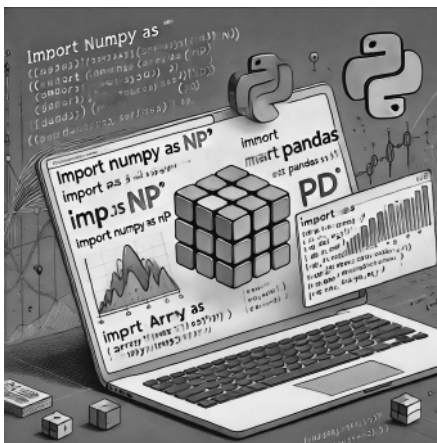
- (c) A Library
- (d) A Data Structure

Ans :

- (a) A Python Package

A package is a collection of related modules stored in a directory containing an `__init__.py` file. This structure allows multiple related modules to be organized and used together.

73. An image shows code using `import numpy as np` and `import pandas as pd`. It also includes functions like `np.array()` and `pd.DataFrame()`. What is this an example of?



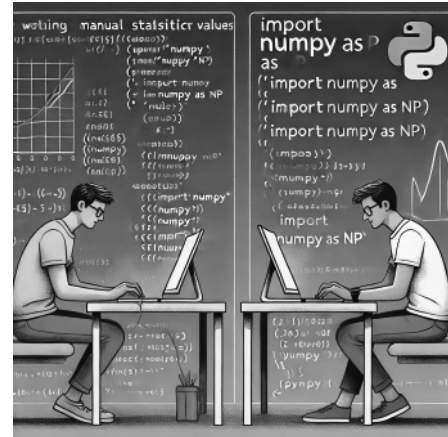
- (a) Modules
- (b) Python Libraries
- (c) File Handling
- (d) A Package

Ans :

- (b) Python Libraries

A library consists of multiple modules and packages providing extensive functionality. NumPy and Pandas are popular Python libraries for numerical operations and data manipulation, respectively.

74. An image shows two developers working. One writes a long code to compute statistical values, while the other uses a single `import numpy as np` and executes calculations in fewer lines. What does this represent?



- (a) Manual Coding
- (b) Reusability and Efficiency of Libraries
- (c) Debugging Process
- (d) Data Cleaning

Ans :

- (b) Reusability and Efficiency of Libraries

Python libraries provide pre-written code that saves time and effort. Instead of writing functions from scratch, developers can use optimized implementations from NumPy, Pandas, SciPy, etc. to perform complex tasks efficiently.

75. An image shows Python code with `import matplotlib.pyplot as plt` and a graph being plotted. What does this demonstrate?



- (a) Data Cleaning
- (b) Library Import and Usage
- (c) A Python Package
- (d) Data Processing

Ans :

- (b) Library Import and Usage

The code `import matplotlib.pyplot as plt` is an example of importing a library to perform specific

46. Which statement about SciPy is correct?
- SciPy is primarily used for creating graphical user interfaces.
  - SciPy extends NumPy by adding functionality for optimization, integration, and more.
  - SciPy is a web framework.
  - SciPy replaces NumPy entirely.

Ans :

MAIN 2014

(b) SciPy extends NumPy by adding functionality for optimization, integration, and more. SciPy builds upon NumPy by providing additional modules for scientific and technical computing tasks, such as integration and optimization.

47. Which statement best describes the role of libraries in Python programming?
- They are only used in academic settings.
  - They provide pre-written code to perform common tasks, improving efficiency and reliability.
  - They slow down the development process.
  - They are optional and rarely used in professional projects.

Ans :

SQP 2021

(b) They provide pre-written code to perform common tasks, improving efficiency and reliability. Libraries encapsulate complex functionality into easy-to-use modules, enabling developers to focus on solving unique problems rather than reinventing basic operations.

48. Which statement about the import statement is correct?
- import module automatically imports all submodules.
  - from module import function imports only the specified function from the module.
  - import module as is invalid syntax.
  - import module.function is the correct way to import a function.

Ans :

COMP 2008

(b) from module import function imports only the specified function from the module. The syntax from module import function imports only the specified function, which is useful for keeping the namespace clean and using only what is necessary.

49. Which statement best describes the relationship between modules, packages, and libraries?
- Modules are a type of library, and packages are standalone programs.

- A package is a collection of modules, and a library is a collection of packages and modules.
- Libraries are written in C only, not Python.
- Modules and packages are only used for data visualization.

Ans :

MAIN 2016

(b) A package is a collection of modules, and a library is a collection of packages and modules. Modules are individual Python files, packages are directories containing related modules, and libraries are comprehensive collections of packages and modules that provide a wide range of functionalities.

50. Which statement about using aliases when importing libraries is correct?
- Aliases are only necessary when using more than one library.
  - Using an alias, such as np for NumPy, helps to write concise and readable code.
  - Aliases make the code slower.
  - Aliases are discouraged in professional projects.

Ans :

SQP 2018

(b) Using an alias, such as np for NumPy, helps to write concise and readable code. Aliases shorten long module names, making code easier to read and write. They are a standard practice in Python programming, particularly for commonly used libraries like NumPy and Pandas.

## ASSERTION AND REASON

51. **Assertion (A)** : A well-defined problem statement is critical for any AI project.

**Reason (R)** : It outlines the project's objectives, scope, and the key factors that affect the problem using the 4 Ws.

- Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- Both Assertion and Reason are correct, but Reason is not the correct explanation.
- Assertion is correct, but Reason is incorrect.
- Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion

Use the syntax `import module_name as alias` (e.g., `import numpy as np`).

- 92.** What is the advantage of using aliases for libraries?

**Ans :** MAIN 2024

Aliases simplify code by shortening module names, improving readability and ease of use.

- 93.** Give one benefit of using Pandas for data analysis.

**Ans :** SQP 2019

Pandas' DataFrame structure simplifies complex data manipulation, cleaning, and analysis, making data handling more efficient.

- 94.** How can you visualize data trends using Matplotlib?

**Ans :** COMP 2011

By plotting line graphs or scatter plots, you can visually analyze trends and relationships in data over time or across variables.

- 95.** What is the difference between a module and a package?

**Ans :** MAIN 2017

A module is a single file containing Python code, while a package is a collection of modules organized within a directory with an `__init__.py` file.

## THREE MARKS QUESTIONS

- 96.** Explain why libraries are crucial in Python programming.

**Ans :** SQP 2022

Libraries allow developers to leverage pre-built, efficient, and reliable code for complex tasks. This speeds up development, reduces errors, and allows programmers to focus on solving unique problems rather than reinventing standard algorithms.

- 97.** Discuss the differences between modules, packages, and libraries in Python.

**Ans :** COMP 2008

A module is a single Python file with code; a package is a directory containing multiple related modules (with an `__init__.py` file); and a

library is a collection of packages and modules that provide extensive functionality, such as NumPy or Pandas.

- 98.** How does the use of NumPy enhance numerical computations in Python?

**Ans :** MAIN 2010

NumPy provides a powerful n-dimensional array object and functions for high-performance mathematical operations, enabling efficient computation and manipulation of large datasets compared to native Python lists.

- 99.** Describe how Pandas facilitates data analysis.

**Ans :** SQP 2009

Pandas offers high-level data structures like DataFrames and Series, which simplify tasks such as data cleaning, merging, filtering, and statistical analysis. These features allow for efficient and flexible manipulation of structured data.

- 100.** What are the benefits of using Matplotlib for data visualization?

**Ans :** COMP 2006

Matplotlib enables the creation of a wide variety of plots and charts, offering customization and interactivity. It helps in visually interpreting data trends and patterns, which is essential for analysis and presenting findings.

- 101.** Why is it important to import libraries using aliases?

**Ans :** MAIN 2013

Using aliases (e.g., `import numpy as np`) shortens code, making it more readable and easier to write. This convention also standardizes code across projects and facilitates quick access to library functions.

- 102.** Explain the role of SciPy in scientific computing.

**Ans :** SQP 2016

SciPy builds on NumPy by providing additional modules for optimization, integration, interpolation, and other complex scientific computations. It is essential for solving higher-level mathematical problems in scientific and engineering applications.

- 103.** How does a DataFrame in Pandas differ from a regular Python dictionary?

indeed create arrays with ``np.array()`.`

**68.** Consider the following statements about Pandas :

1. Pandas is used for data manipulation and analysis, particularly through its DataFrame object.
  2. You can create a DataFrame by passing a dictionary to the ``pd.DataFrame()`. constructor.`
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

Pandas is a powerful library for data manipulation and analysis, and creating a DataFrame using a dictionary is a common practice.

**69.** Consider the following statements about Matplotlib :

1. Matplotlib is used to create static, animated, and interactive visualizations in Python.
  2. After plotting data with ``plt.plot()`. calling `plt.show()`. is necessary to display the graph.`
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

Matplotlib is widely used for various types of visualizations, and ``plt.show()`. is required to render and display the plotted figures.`

**70.** Consider the following statements about SciPy :

1. SciPy is a library for scientific and technical computing, offering functionalities such as optimization and integration.
  2. The function ``integrate.quad`. from SciPy returns both the computed integral value and an error estimate.`
- (a) Only statement 1 is correct.  
 (b) Only statement 2 is correct.  
 (c) Both statements 1 and 2 are correct.  
 (d) Neither statement 1 nor 2 is correct.

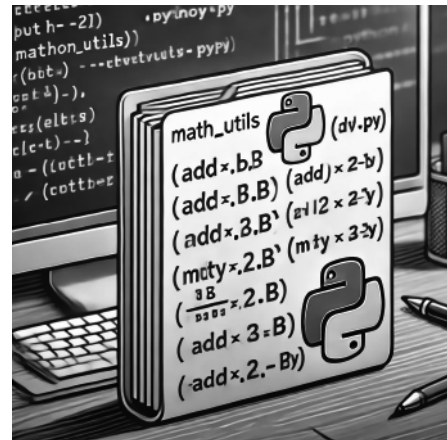
**Ans :**

(c) Both statements 1 and 2 are correct.

SciPy is tailored for scientific computing, and its integration function ``integrate.quad`. indeed returns a tuple containing the integral result and an estimate of the error.`

## PICTURE BASED QUESTIONS

- 71.** An image shows a Python file named `math_utils.py` containing several functions such as `add(a, b)` and `multiply(a, b)`. What does this file represent?



- (a) A Python Library  
 (b) A Module  
 (c) A Package  
 (d) A DataFrame

**Ans :**

(b) A Module

A module is a single Python file containing functions, classes, or variables that can be reused in other programs. The file `math_utils.py` serves as a module that provides helper functions.

- 72.** An image depicts a directory structure containing a folder named `data_processing` with two files : `cleaning.py` and `transform.py`, along with `__init__.py`. What does this represent?



- (a) A Python Package  
 (b) A Module

makes code more manageable, modular, and easier to maintain. This organization facilitates reuse and scalability in larger projects.

- 115.** What is the benefit of using SciPy's integration functions?

**Ans :**

MAIN 2015

SciPy's integration functions, such as `integrate.quad()`, allow for accurate numerical integration of functions, which is essential for solving complex mathematical problems in scientific computing without manually implementing integration algorithms.

## NINE MARKS QUESTION

- 116.** Write a Python program to perform the following operations :

1. Create a list of even numbers : `[2, 4, 6, 8, 10]`.
2. Append the number `12` to the list.
3. Insert the number `5` at index 2.
4. Reverse the list.
5. Convert the list to a NumPy array and print its shape.
6. Calculate the sum of the elements using NumPy.
7. Print the final list and array.

**Ans :**

MAIN 2025

```
import numpy as np
Step 1: Create a list of even numbers
numbers = [2, 4, 6, 8, 10]
Step 2: Append the number 12
numbers.append(12)
Step 3: Insert the number 5 at index 2
numbers.insert(2, 5)
Step 4: Reverse the list
numbers.reverse()
Step 5: Convert the list to a NumPy array
num_array = np.array(numbers)
Step 6: Calculate the sum of the elements using NumPy
sum_numbers = np.sum(num_array)
Step 7: Print the final list and array
print("Final List:", numbers)
print("NumPy Array:", num_array)
print("Array Shape:", num_array.shape)
print("Sum of Elements:", sum_numbers)
```

- 117.** Write a Python program to :

1. Create a list of fruit names : `['Apple', 'Banana', 'Cherry', 'Mango', 'Grapes']`.
2. Append the fruit `Orange` to the list.
3. Insert `Pineapple` at index 3.
4. Sort the list in alphabetical order.
5. Find the index of `Mango` and print it.
6. Print the final list.

**Ans :**

SQP 2024

```
Step 1: Create a list of fruit names
fruits = ['Apple', 'Banana', 'Cherry', 'Mango', 'Grapes']
Step 2: Append 'Orange' to the list
fruits.append('Orange')
Step 3: Insert 'Pineapple' at index 3
fruits.insert(3, 'Pineapple')
Step 4: Sort the list in alphabetical order
fruits.sort()
Step 5: Find the index of 'Mango'
mango_index = fruits.index('Mango')
Step 6: Print the final list and index of 'Mango'
print("Final List:", fruits)
print("Index of 'Mango':", mango_index)
```

- 118.** Write a Python program to :

1. Create a Pandas DataFrame with columns `Name`, `Subject`, and `Marks`.
2. Add three students with their marks.
3. Insert a new row with student `David` and his marks `85` in `Math`.
4. Sort the DataFrame based on marks in descending order.
5. Print the final DataFrame.

**Ans :**

COMP 2021

```
import pandas as pd
Step 1: Create a DataFrame with columns 'Name', 'Subject', and 'Marks'
data = {
 'Name': ['Alice', 'Bob', 'Charlie'],
 'Subject': ['Math', 'Science', 'English'],
 'Marks': [90, 78, 88]
}
df = pd.DataFrame(data)
Step 2: Insert a new row with student 'David' and his marks 85 in 'Math'
new_row = pd.DataFrame({'Name': ['David'], 'Subject': ['Math'], 'Marks': [85]})
df = pd.concat([df, new_row], ignore_index=True)
Step 3: Sort the DataFrame based on marks in descending order
df = df.sort_values(by='Marks', ascending=False)
```

- 127.** A startup wants to develop a dashboard that visualizes sales data. Which libraries would be most useful, and why?

**Ans :**

Pandas would be used for data manipulation and cleaning, while Matplotlib (or Seaborn, built on Matplotlib) would create visualizations like bar charts and line graphs. These libraries streamline the process of converting raw data into clear, actionable visual insights.

- 128.** A student is writing a Python script to analyze exam scores stored in a CSV file. Describe how they might use Pandas.

**Ans :**

The student can use Pandas to read the CSV file into a DataFrame, clean and filter the data, perform statistical analysis (mean, median, etc.), and generate plots to visualize score distributions, all with a few lines of code.

- 129.** An engineer needs to integrate a mathematical function over a given range. Which library and function would they likely use, and why?

**Ans :**

The engineer would use SciPy's integration functions, such as `integrate.quad()`, because SciPy is built for scientific computations and provides reliable numerical integration methods that save time and reduce potential errors.

- 130.** A company is developing an AI system for automated reporting. Explain how using Python libraries can reduce development time.

**Ans :**

By leveraging libraries like Pandas for data handling, Matplotlib for visualization, and NumPy for numerical computations, developers can use pre-built, optimized functions instead of writing complex code from scratch. This accelerates development and ensures robust, tested implementations.

- 131.** A teacher wants to demonstrate the difference between importing an entire module and specific functions. Provide an example.

**Ans :**

The teacher can show that using `import math` requires referencing functions with `math.sqrt()`, whereas from `math import sqrt` allows calling

`sqrt()` directly. This practical example clarifies namespace management and code readability.

- 132.** An application requires processing millions of numbers quickly. Why would a developer choose NumPy over standard Python lists?

**Ans :**

NumPy is optimized for numerical operations on large arrays using vectorized operations implemented in C, which makes it significantly faster and more memory-efficient than standard Python lists.

- 133.** A research team is exploring climate data trends. How can Matplotlib aid in their analysis?

**Ans :**

Matplotlib can plot time series data, scatter plots, and histograms to reveal trends, correlations, and anomalies in climate variables. Visualizations help the team interpret complex data and communicate findings effectively.

- 134.** A software developer is working on a machine learning project that involves financial data. Which libraries are essential, and what is their role?

**Ans :**

Essential libraries include Pandas (for data manipulation and cleaning), NumPy (for numerical operations), Matplotlib (for visualizing trends), and SciPy (for statistical analysis). These tools facilitate preprocessing, feature extraction, and exploratory analysis before model building.

- 135.** A student wants to build a simple Python program to display a graph of students' test scores. Outline the steps using appropriate libraries.

**Ans :**

First, use Pandas to load and clean the test scores from a CSV file. Then, employ Matplotlib to create a bar or line graph showing score distributions. Finally, use appropriate labels and titles to make the visualization clear and informative.

- 136.** A developer needs to perform efficient numerical operations, including array manipulation and linear algebra, in a Python project. Which library is most suitable for this task, and how should it be imported?

**Ans :**

**123.** Write a Python program to :

1. Create a Pandas DataFrame with columns 'Student' and 'Score'.
2. Add data for four students.
3. Insert a new column 'Grade' where a score  $\geq 80$  is 'A', 60-79 is 'B', and below 60 is 'C'.
4. Sort the DataFrame based on scores in descending order.
5. Print the final DataFrame.

**Ans :**

SQP 2006

import pandas as pd

Step 1: Create a DataFrame with columns 'Student' and 'Score'

```
data = {
 'Student': ['Alice', 'Bob', 'Charlie', 'David'],
 'Score': [85, 72, 90, 55]
}
```

```
df = pd.DataFrame(data)
```

Step 2: Insert a new column 'Grade' based on score ranges

```
def assign_grade(score):
 if score >= 80:
 return 'A'
 elif 60 <= score < 80:
 return 'B'
 else:
 return 'C'
```

```
df['Grade'] = df['Score'].apply(assign_grade)
```

Step 3: Sort the DataFrame based on scores in descending order

```
df = df.sort_values(by='Score', ascending=False)
```

Step 4: Print the final DataFrame

```
print(df)
```

**124.** Write a Python program to :

1. Create a dictionary of cities and their populations :  
{ 'New York' : 8.4, 'Los Angeles' : 4.0, 'Chicago' : 2.7, 'Houston' : 2.3, 'Phoenix' : 1.7 }
2. Extract the city names and populations as separate lists.
3. Use Matplotlib to plot a bar chart representing the population of each city.

**Ans :**

COMP 2010

```
import matplotlib.pyplot as plt
```

Step 1 : Define city population data

```
city_population = { 'New York' : 8.4, 'Los Angeles' : 4.0, 'Chicago' : 2.7, 'Houston' : 2.3, 'Phoenix' : 1.7 }
```

Step 2 : Extract keys and values

```
cities = list(city_population.keys())
```

```
populations = list(city_population.values())
```

Step 3 : Plot bar chart

```
plt.bar(cities, populations)
```

```
plt.xlabel("Cities")
```

```
plt.ylabel("Population (Millions)")
```

```
plt.title("City Population Chart")
```

```
plt.xticks(rotation=30)
```

```
plt.show()
```

**125.** Write a Python program to :

1. Use SciPy to compute the integral of  $f(x) = e^{-x^2}$  from  $-\infty$  to  $\infty$ .
2. Print the result.

**Ans :**

MAIN 2022

```
from scipy import integrate
```

```
import numpy as np
```

Define the function

```
f = lambda x : np.exp(-x2)
```

Compute integral from  $-\infty$  to  $\infty$

```
result, error = integrate.quad(f, -np.inf, np.inf)
```

```
print("Integral of e^{-x^2} from $-\infty$ to ∞ :", result)
```

1. List operations (sorting, inserting, finding max/min values).
2. NumPy operations (element-wise addition, mean, standard deviation, finding max index).
3. Pandas DataFrame manipulations (creating, inserting a column, sorting).
4. Matplotlib visualization (bar chart for city population).
5. SciPy numerical integration (Gaussian integral computation).

## CASE BASED QUESTION

- 126.** A data analyst needs to process a large dataset of sensor readings for a research project. Explain how NumPy and Pandas would help.

**Ans :**

NumPy can efficiently store and manipulate large numerical arrays, while Pandas offers DataFrames for tabular data. Together, they enable quick calculations, data cleaning, filtering, and summarization, significantly reducing processing time compared to pure Python loops.

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## MULTIPLE CHOICE QUESTION

1. What is a Python list?

- (a) An immutable collection
- (b) A mutable, ordered collection
- (c) A key-value pair structure
- (d) A function

Ans :

MAIN 2025

(b) A mutable, ordered collection

A list is a mutable and ordered collection in Python. It allows you to store multiple items and modify them later (by adding, deleting, or updating elements), which distinguishes it from immutable data types like tuples.

2. How do you create a list in Python?

- (a) Using curly braces {}
- (b) Using parentheses ()
- (c) Using square brackets []
- (d) Using angle brackets <>

Ans :

SQP 2024

(c) Using square brackets []

Lists in Python are created by placing items inside square brackets, separated by commas. For example, [1, 2, 3] is a list. Curly braces denote dictionaries or sets, while parentheses are used for tuples.

3. Which operation adds a single element to the end of a list?

- (a) insert()
- (b) extend()
- (c) append()
- (d) sort()

Ans :

COMP 2021

(c) append()

The append() method adds a single element to the end of a list. In contrast, insert() adds an element at a specific index, and extend() concatenates another list. sort() arranges the elements in order.

4. What does the insert() method do?

- (a) Appends an element at the end
- (b) Adds an element at a specified index
- (c) Merges two lists
- (d) Removes an element

Ans :

MAIN 2023

(b) Adds an element at a specified index

The insert() method places an element at the specified index within the list. For example, list.

insert(2, "apple") inserts "apple" at index 2, shifting subsequent elements to the right.

5. Which method is used to add multiple elements from one list to another?

- (a) append()
- (b) insert()
- (c) extend()
- (d) sort()

Ans :

SQP 2019

(c) extend()

The extend() method is used to add all elements of another list to the end of the current list. Unlike append(), which adds the list as a single element, extend() unpacks the elements into the original list.

6. What does the sort() method do?

- (a) Rearranges a list in ascending (or descending) order
- (b) Removes duplicate values
- (c) Converts a list to a tuple
- (d) Searches for an element

Ans :

COMP 2015

(a) Rearranges a list in ascending (or descending) order

The sort() method orders the list elements in ascending order by default. It can also sort in descending order by specifying the parameter reverse=True. Sorting only works properly when all elements are of comparable types.

7. Which operator can be used to search for an element in a list?

- (a) ==
- (b) in
- (c) !=
- (d) is

Ans :

MAIN 2016

(b) in

The in operator checks if an element exists within a list and returns True or False. For example, "apple" in my\_list returns True if "apple" is present.

8. What is a Python tuple?

- (a) A mutable, ordered collection
- (b) An immutable, ordered collection
- (c) A collection of key-value pairs
- (d) A method for looping

Ans :

SQP 2013

They should use NumPy, which is optimized for numerical computations and array operations.

```
`import numpy as np`
arr = np.array([1, 2, 3, 4, 5])`
```

Using NumPy not only simplifies array handling but also ensures performance improvements due to its optimized C-backed routines.

- 137.** A data analyst wants to work with structured data in tabular form to perform data manipulation and analysis. Which library should they use, and what is the standard way to import it?

**Ans :**

They should use Pandas for handling data with DataFrames, which are ideal for structured data manipulation.

```
`import pandas as pd`
data = {'Name' : ['Alice', 'Bob'], 'Age' : [25, 30]}
df = pd.DataFrame(data)
print(df)`
```

Pandas offers robust, high-level data manipulation capabilities that streamline the process of data analysis.

- 138.** A scientific programmer needs to perform numerical integration and optimization as part of their research. Which library is most appropriate, and how can one import its integration module?

**Ans :**

They should use SciPy for scientific computing tasks such as numerical integration and optimization.

```
`from scipy import integrate`
result, error = integrate.quad(lambda x : x2, 0, 1)
print("Integral of x2 from 0 to 1 :", result)`
```

SciPy provides reliable and well-tested functions that simplify complex mathematical operations in scientific applications.

- 139.** A developer wants to visualize data with interactive graphs and plots. Which library is ideal for this purpose, and what is the common alias used when importing its plotting module?

**Ans :**

They should use Matplotlib, specifically its `pyplot` module, which is commonly imported with the alias `plt`.

```
`import matplotlib.pyplot as plt`
x = [0, 1, 2, 3, 4]
y = [0, 1, 4, 9, 16]
plt.plot(x, y)
plt.xlabel('X-axis')
```

```
plt.ylabel('Y-axis')
plt.title('Line Graph Example')
plt.show()`
```

Matplotlib's extensive plotting functions enable developers to create a wide range of visualizations quickly and efficiently.

- 140.** In a Python project, how can you import an entire module versus importing only a specific function from that module? Provide code examples for each case.

**Ans :**

To import an entire module, you use the standard `import` statement; to import a specific function, you use the `from ... import ...` syntax.

```
`import math` # Imports the entire module
result = math.sqrt(16) # Using a function from math
from math import sqrt # Imports only the sqrt function
result = sqrt(16)`
```

This flexibility in importing allows developers to manage namespace clutter and improve code readability by importing only what is needed.

- 141.** You have a file named `math\_utils.py` containing several helper functions. How can you use these functions in another Python file located in the same directory?

**Ans :**

They should import the module using its filename (without the .py extension) with the standard import syntax.

```
`import math_utils`
result = math_utils.some_helper_function(5)`
This modular design encourages code reuse and maintains separation of concerns by keeping helper functions in a dedicated file.
```

- 142.** A project organizes related modules in a directory named `data\_processing` (which contains an `\_\_init\_\_.py` file) with modules such as `cleaning.py` and `transform.py`. How would you import the `transform` module from this package?

**Ans :**

They can import the module using the package name followed by the module name.

```
`from data_processing import transform`
or
```

```
import data_processing.transform as trans`
```

Having an `__init__.py` file designates the directory as a package, making module imports straightforward and organized.

- 143.** What is the purpose of the `__init__.py` file in a package, and why is it important for package organization in Python?

**Ans :**

The `__init__.py` file signals to Python that the directory should be treated as a package, allowing for the proper import of its modules.

An empty `__init__.py` is sufficient to declare a package.

This file is critical for package initialization and can also be used to execute package-level setup code if needed.

- 144.** How do libraries enhance development efficiency, and what are some key benefits of using pre-written libraries in Python?

**Ans :**

Libraries offer pre-written, optimized, and well-tested code that saves time and reduces the risk of bugs in complex tasks.

For example, using NumPy, Pandas, and Matplotlib allows developers to focus on problem-solving rather than low-level implementation details.

They also come with extensive documentation and community support, making it easier to integrate robust functionality into projects.

- 145.** A developer aims to rapidly prototype a project involving array operations, data manipulation, and visualization without reinventing the wheel. How do libraries help in this scenario?

**Ans :**

Libraries like NumPy, Pandas, and Matplotlib provide ready-to-use functions and classes that handle array computations, data processing, and plotting.

```
`import numpy as np
```

```
import pandas as pd
```

```
import matplotlib.pyplot as plt
```

These libraries allow rapid development by abstracting complex tasks.

Leveraging these libraries accelerates development, allowing the developer to focus on higher-level logic and innovation.

# CHAPTER 10

## LISTS AND TUPLES IN PYTHON

### SUMMARY

#### 1. INTRODUCTION TO LISTS

A list is an ordered, mutable collection of items in Python. Lists can hold elements of different data types.

##### 1.1 Creation

Lists are created using square brackets.

```
my_list = [1, 2, 3, "apple", "banana"]
```

##### 1.2 Accessing Elements

Elements are accessed by index (starting at 0).

```
first_element = my_list[0] # returns 1
```

#### 2. COMMON LIST OPERATIONS

1. Append: Adds an element to the end.  

```
my_list.append("cherry")
```
2. Insert: Inserts an element at a specified index.  

```
my_list.insert(2, "orange") # Inserts 'orange' at index 2
```
3. Extend: Adds all elements of another list.  

```
my_list.extend([7, 8, 9])
```
4. Sort: Arranges the list in ascending (or descending) order (only for homogeneous types).  

```
numbers = [3, 1, 4, 2]
numbers.sort() # numbers becomes [1, 2, 3, 4]
```
5. Search: Use the in operator or the index() method to locate an element.  

```
if "apple" in my_list:
 pos = my_list.index("apple")
```

#### 3. TUPLES

A tuple is an ordered, immutable collection of items in Python. Once created, its elements cannot be modified.

##### 3.1 Creation

Tuples are created using parentheses (or without any delimiters in some cases).

```
my_tuple = (1, 2, 3, "apple", "banana")
```

##### 3.2 Accessing Elements

Like lists, tuple elements are accessed by index.

```
first_item = my_tuple[0] # returns 1
```

##### 3.3 Deleting Tuples

Individual tuple elements cannot be deleted since tuples are immutable. However, you can delete the entire tuple:

```
del my_tuple # deletes the tuple completely
```

#### 4. CONVERSION BETWEEN LISTS AND TUPLES

1. List to Tuple:  

```
tuple_version = tuple(my_list)
```
2. Tuple to List:  

```
list_version = list(my_tuple)
```

#### 5. WHY USE LISTS AND TUPLES?

##### 5.1 Lists

1. Ideal when you need a mutable, ordered collection.
2. Frequently used in loops, data manipulation, and when elements may need to be added or removed.

##### 5.2 Tuples

1. Useful when the data should not change (e.g., coordinates, fixed configuration values).
2. They are faster than lists due to immutability and can be used as keys in dictionaries.

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17. What is the result of calling `my_list.append(10)` on the list `[1, 2, 3]`?

(a) `[10, 1, 2, 3]`  
 (b) `[1, 2, 3, 10]`  
 (c) `[1, 2, 10, 3]`  
 (d) `[1, 10, 2, 3]`

Ans :

SQP 2022

(b) `[1, 2, 3, 10]`

The `append()` method adds the element to the end of the list. Therefore, the list `[1, 2, 3]` becomes `[1, 2, 3, 10]`.

18. If `t = (1, 2, 3)`, what does `t[1]` return?

(a) 1  
 (b) 2  
 (c) 3  
 (d) An error

Ans :

COMP 2008

(b) 2

Since indexing starts at 0, `t[1]` returns the second element of the tuple `t`, which is 2.

19. Which method would you use to find the index of an element in a list?

(a) `index()`  
 (b) `find()`  
 (c) `search()`  
 (d) `locate()`

Ans :

MAIN 2010

(a) `index()`

The `index()` method returns the first index at which a specified value is found in a list. For example, `my_list.index("apple")` returns the index of "apple" in the list.

20. Which of the following operations can be used to concatenate two lists?

(a) `+` operator  
 (b) `operator`  
 (c) `append()`  
 (d) `sort()`

Ans :

SQP 2014

(a) `+` operator

The `+` operator can be used to concatenate two lists by returning a new list that combines the elements of both lists.

21. What is the purpose of using the `del` keyword with a tuple?

(a) To change an element within the tuple  
 (b) To delete the entire tuple from memory

(c) To convert the tuple to a list  
 (d) To add elements to the tuple

Ans :

COMP 2012

(b) To delete the entire tuple from memory

Since tuples are immutable, you cannot delete individual elements. However, you can delete the entire tuple from memory using the `del` keyword.

22. Which list method would you use to add all elements from another list to the current list?

(a) `append()`  
 (b) `extend()`  
 (c) `insert()`  
 (d) `remove()`

Ans :

MAIN 2016

(b) `extend()`

The `extend()` method takes an iterable (such as another list) and appends each element to the current list, effectively concatenating them.

23. What is the output of `tuple([1, 2, 3])`?

(a) `[1, 2, 3]`  
 (b) `(1, 2, 3)`  
 (c) `{1, 2, 3}`  
 (d) `1, 2, 3`

Ans :

SQP 2021

(b) `(1, 2, 3)`

Converting a list to a tuple using `tuple()` produces an immutable sequence with the same elements, so the output is `(1, 2, 3)`.

24. Which operation would raise an error when applied to a tuple?

(a) Accessing an element by index  
 (b) Converting it to a list  
 (c) Appending an element using `append()`  
 (d) Iterating over its elements

Ans :

COMP 2023

(c) Appending an element using `append()`

Tuples are immutable, so attempting to modify them (e.g., using `append()`) will result in an error. You can, however, access and iterate over tuple elements, or convert the tuple to a list for modification.

25. Which method searches for an element in a list and returns its index?

(a) `find()`  
 (b) `search()`  
 (c) `index()`  
 (d) `locate()`

(b) An immutable, ordered collection  
Tuples are immutable collections in Python. Once created, their contents cannot be changed. They are defined with parentheses, e.g., (1, 2, 3), and are useful for storing fixed data.

- 9.** How do you create a tuple in Python?
- Using square brackets []
  - Using curly braces {}
  - Using parentheses ()
  - Using angle brackets <>

**Ans :** COMP 2006

(c) Using parentheses ()  
Tuples are created by enclosing items within parentheses. For example, (1, 2, 3) creates a tuple. Although parentheses can sometimes be omitted in certain contexts, using them makes the tuple explicit.

- 10.** How do you access an element in a tuple?
- Using curly braces
  - Using an index in square brackets
  - Using the get() method
  - You cannot access tuple elements

**Ans :** MAIN 2012

(b) Using an index in square brackets  
Tuple elements are accessed via indexing, similar to lists. For example, my\_tuple[0] retrieves the first element. Even though tuples are immutable, their elements can still be read.

- 11.** How can you delete an entire tuple?
- Using the del statement
  - Using the remove() method
  - Using the pop() method
  - Tuples cannot be deleted

**Ans :** SQP 2018

(a) Using the del statement  
Although individual elements of a tuple cannot be removed, you can delete an entire tuple using the del statement, e.g., del my\_tuple.

- 12.** What happens if you try to change an element in a tuple?
- The element changes successfully
  - An error is raised because tuples are immutable
  - The tuple converts to a list automatically
  - The element becomes None

**Ans :** COMP 2011

(b) An error is raised because tuples are immutable

Tuples are immutable, so attempting to modify an element results in a TypeError. This immutability is one of the defining characteristics of tuples.

- 13.** How can you convert a list to a tuple?
- Using list()
  - Using tuple()
  - Using convert()
  - You cannot convert a list to a tuple

**Ans :** MAIN 2009

(b) Using tuple()  
The tuple() function converts a list into a tuple by passing the list as an argument. For example, tuple(my\_list) returns a tuple with the same elements as my\_list.

- 14.** How can you convert a tuple to a list?
- Using tuple()
  - Using list()
  - Using convert()
  - Tuples cannot be converted

**Ans :** SQP 2014

(b) Using list()  
The list() function converts a tuple into a list. For example, list(my\_tuple) returns a list containing the elements of my\_tuple, which then can be modified if needed.

- 15.** Which of the following list operations does not modify the list in place?
- append()
  - insert()
  - extend()
  - The sorted() function

**Ans :** COMP 2007

(d) The sorted() function  
The sorted() function returns a new sorted list and does not modify the original list. In contrast, methods like append(), insert(), and extend() change the list in place.

- 16.** Which of the following is true regarding list indexing in Python?
- Indexing starts at 1
  - Indexing starts at 0
  - Indexing is random
  - Indexing cannot be performed on lists

**Ans :** MAIN 2017

(b) Indexing starts at 0  
Python uses zero-based indexing, meaning the first element of a list is accessed with index 0, the second with index 1, and so on.

Step 4: Print the final DataFrame  
`print(df)`

**119.** Write a Python program to :

1. Create a dictionary with car brands and their sales :
2. Extract the keys as brands and values as sales numbers.
3. Use Matplotlib to plot a pie chart of car sales.

**Ans :**

MAIN 2023

`import matplotlib.pyplot as plt`

Step 1: Create a dictionary with car brands and their sales

```
car_sales = {
 'Toyota': 500,
 'Ford': 350,
 'BMW': 200,
 'Tesla': 450,
 'Honda': 300
}
```

Step 2: Extract keys as brands and values as sales numbers

```
brands = list(car_sales.keys())
sales_numbers = list(car_sales.values())
Step 3: Plot a pie chart of car sales
plt.figure(figsize=(7, 7))
plt.pie(sales_numbers, labels=brands,
 autopct='%1.1f%%', startangle=140,
 wedgeprops={'edgecolor': 'black'})
plt.title("Car Sales Distribution")
plt.show()
```

**120.** Write a Python program to :

1. Use SciPy to compute the integral of  $f(x) = \sin(x)$  from  $0$  to  $\pi$ .
2. Print the result.

**Ans :**

SQP 2013

`import scipy.integrate as spi`

`import numpy as np`

Define the function  $f(x) = \sin(x)$

```
def f(x):
 return np.sin(x)
```

Compute the integral from  $0$  to  $\pi$

`result, error = spi.quad(f, 0, np.pi)`

Print the result

`print("Integral of  $\sin(x)$  from  $0$  to  $\pi$ :", result)`

**121.** Write a Python program to perform the following operations :

1. Create a list of integers : `[15, 5, 25, 10, 30]`.

2. Append the integer 40 to the list.
3. Insert the integer 20 at index 3.
4. Sort the list in ascending order.
5. Find the maximum and minimum values from the list and print them.
6. Print the final list.

**Ans :**

COMP 2016

Step 1: Create a list of integers

```
numbers = [15, 5, 25, 10, 30]
```

Step 2: Append the integer 40 to the list  
`numbers.append(40)`

Step 3: Insert the integer 20 at index 3  
`numbers.insert(3, 20)`

Step 4: Sort the list in ascending order  
`numbers.sort()`

Step 5: Find the maximum and minimum values from the list

```
max_value = max(numbers)
```

```
min_value = min(numbers)
```

Step 6: Print the final list and min/max values

```
print("Final List:", numbers)
```

```
print("Maximum Value:", max_value)
```

```
print("Minimum Value:", min_value)
```

**122.** Write a Python program to :

1. Create a NumPy array `[10, 20, 30, 40, 50]`.
2. Add 5 to each element in the array.
3. Find the mean and standard deviation of the array.
4. Find the index of the maximum value in the array.
5. Print the modified array and computed values.

**Ans :**

MAIN 2019

`import numpy as np`

Step 1: Create a NumPy array

```
arr = np.array([10, 20, 30, 40, 50])
```

Step 2: Add 5 to each element in the array

```
arr_modified = arr + 5
```

Step 3: Find the mean and standard deviation

```
mean_value = np.mean(arr_modified)
```

```
std_deviation = np.std(arr_modified)
```

Step 4: Find the index of the maximum value in the array

```
max_index = np.argmax(arr_modified)
```

Step 5: Print the modified array and computed values

```
print("Modified Array:", arr_modified)
```

```
print("Mean of the Array:", mean_value)
```

```
print("Standard Deviation of the Array:", std_deviation)
```

```
print("Index of Maximum Value:", max_index)
```

**Ans :**

MAIN 2023

(b) search()  
The index() method in Python lists returns the index of the first occurrence of a specified element. It is the standard method used for searching for elements in a list.

**26.** How can you convert a tuple t to a list?

- (a) list(t)
- (b) tuple(t)
- (c) convert(t)
- (d) t.toList()

**Ans :**

SQP 2015

(a) list(t)  
The built-in list() function converts a tuple into a list, allowing for modifications since lists are mutable.

**27.** How do you access the last element of a list my\_list?

- (a) my\_list[0]
- (b) my\_list[-1]
- (c) my\_list[1]
- (d) my\_list.last()

**Ans :**

COMP 2018

(b) my\_list[-1]  
In Python, negative indexing is used to access elements from the end of the list. my\_list[-1] returns the last element.

**28.** What is the result of the following code?

```
lst = [1, 2, 3]
lst.insert(1, 99)
print(lst)
```

- (a) [1, 99, 2, 3]
- (b) [99, 1, 2, 3]
- (c) [1, 2, 3, 99]
- (d) [99, 2, 3]

**Ans :**

MAIN 2007

(a) [1, 99, 2, 3]  
The insert(1, 99) method places the value 99 at index 1. The original element at index 1 (2) and subsequent elements are shifted to the right, resulting in [1, 99, 2, 3].

**29.** Which function would you use to check if an element exists in a list?

- (a) exists()
- (b) contains()
- (c) The in operator
- (d) find()

**Ans :**

SQP 2008

(c) The in operator  
The in operator is used to check whether an element exists in a list. For example, "apple" in my\_list returns True if "apple" is present.

**30.** What is the effect of calling extend() on a list?

- (a) It adds the provided element as a single item
- (b) It sorts the list
- (c) It appends each element of the provided iterable to the list
- (d) It removes duplicate elements

**Ans :**

COMP 2022

(c) It appends each element of the provided iterable to the list  
The extend() method takes an iterable (such as another list) and adds each of its elements to the end of the current list, thereby merging the two lists.

**31.** A beginner is learning Python and needs to store a mix of numbers and strings for later processing. Which data structure should they use?

- (a) List
- (b) Tuple
- (c) Dictionary
- (d) Set

**Ans :**

MAIN 2017

(a) List  
In this scenario, a list is ideal because it is an ordered, mutable collection supporting heterogeneous data types. Lists allow modifications such as appending, inserting, and extending elements. Their flexibility makes them indeed suitable for beginners who need to store and manipulate various numbers, strings, and objects in Python effectively.

**32.** A developer must store fixed configuration values that should never change during program execution.

Which data structure is best suited for this purpose?

- (a) List
- (b) Tuple
- (c) Dictionary
- (d) Set

**Ans :**

SQP 2011

(b) Tuple  
In this scenario, a tuple is the ideal choice because tuples are immutable, meaning their contents cannot be modified after creation. This property

ensures fixed configuration values remain constant throughout execution. Moreover, tuples are faster than lists and can serve as dictionary keys, providing efficiency and stability in program behavior.

- 33.** A programmer needs to add the element `“cherry”` to the end of an existing fruit list. Which method should they use?
- `append()`
  - `insert()`
  - `extend()`
  - `sort()`

**Ans :**

COMP 2019

- (a) `append()`

In this scenario, the `append()` method is the correct choice because it adds a single element to the end of the list. This operation is useful when incrementally building a list or updating a collection dynamically. Append ensures the list remains ordered and efficiently incorporates new data consistently every time.

- 34.** A developer wants to insert `“orange”` into a list at index 2 to maintain a specific order. Which method is most appropriate?
- `append()`
  - `insert()`
  - `extend()`
  - `sort()`

**Ans :**

MAIN 2024

- (b) `insert()`

In this case, the `insert()` method is appropriate because it allows adding an element at a specified index in a list. By using `insert()`, the programmer can control the position of the new element, preserving the desired order and structure of the list while modifying it according to requirements effectively.

- 35.** A programmer has a list of numbers, `[3, 1, 4, 2]`, and needs to arrange them in ascending order. Which method should they call?
- `sort()`
  - `append()`
  - `insert()`
  - `extend()`

**Ans :**

SQP 2023

- (a) `sort()`

In this scenario, the `sort()` method is used to arrange the elements of the list in ascending order. Sorting is particularly effective for homogeneous types, ensuring that numerical values are ordered

correctly. This operation reorganizes the list in place, providing a systematic and efficient way to manage data sequences effectively.

- 36.** A developer writes the statement:  
if `“apple”` in `my_list`:  
`pos = my_list.index(“apple”)`  
What does this code do?
- Appends `“apple”` to the list
  - Checks for `“apple”` and retrieves its index
  - Inserts `“apple”` at a specified position
  - Removes `“apple”` from the list

**Ans :**

COMP 2025

- (b) Checks for `“apple”` and retrieves its index

In this case, the code first checks if the element `“apple”` exists within the list using the `in` operator. If found, the `index()` method retrieves its position. This approach allows the programmer to verify element presence and accurately determine its index for further data manipulation tasks effectively.

- 37.** A developer needs to ensure that a list's contents remain unchangeable, so they decide to convert it. Which code correctly converts a list to a tuple?
- `list(my_tuple)`
  - `tuple(my_list)`
  - `my_list.to_tuple()`
  - `convert(my_list)`

**Ans :**

MAIN 2013

- (b) `tuple(my_list)`

In this scenario, converting a mutable list to an immutable tuple is achieved using the `tuple()` constructor. This conversion ensures that the data remains unchanged throughout program execution. It is useful when a fixed collection is needed, allowing the programmer to benefit from tuple immutability while preserving the list content.

- 38.** A programmer has a tuple of coordinates that needs modification. Realizing tuples are immutable, they decide to change it. What is the correct approach?
- Use the `append()` method
  - Directly assign a new value to an index
  - Convert the tuple to a list, modify it, then convert back
  - Use the `insert()` method

**Ans :**

SQP 2006

- (c) Convert the tuple to a list, modify it, then convert back

In this scenario, since tuples are immutable, direct modification is impossible. Instead, the developer must convert the tuple into a list, perform the modifications, and then convert the list back into a tuple. This approach allows updating the collection while maintaining the immutable property of the final data structure effectively.

- 39.** A programmer selects a list because their application requires frequent additions and removals of elements during runtime. Which property makes lists ideal for this task?
- (a) Mutability
  - (b) Immutability
  - (c) Fixed order
  - (d) Inability to convert

**Ans :**

COMP 2009

- (a) Mutability

In this scenario, lists are chosen because they are mutable, allowing elements to be added, removed, or modified during runtime. This flexibility is essential for dynamic data manipulation. Mutability provides programmers with the ability to adjust collections as needed, making lists ideal for applications where data changes over time effectively.

- 40.** A software engineer must store user login credentials that must remain unchanged once set. Which data structure is more appropriate?
- (a) List
  - (b) Tuple
  - (c) Both
  - (d) Neither

**Ans :**

MAIN 2022

- (b) Tuple

In this scenario, tuples are more appropriate for storing user login credentials because they are immutable, ensuring that the data remains constant after creation. The immutability prevents accidental modifications, enhancing security and reliability. This characteristic makes tuples ideal for fixed, sensitive information where integrity is critical during program execution effectively.

- 41.** Which statement best describes the purpose of lists in Python?
- (a) Lists store immutable data
  - (b) Lists store mutable, ordered collections of items
  - (c) Lists store key-value pairs only
  - (d) Lists cannot be modified once created

**Ans :**

SQP 2024

- (b) Lists store mutable, ordered collections of items

Lists in Python are designed to store an ordered sequence of elements that can be modified—items can be added, removed, or changed. This flexibility makes them ideal for dynamic data manipulation compared to immutable structures like tuples.

- 42.** Which statement best describes the difference between lists and tuples?
- (a) Lists are immutable, tuples are mutable
  - (b) Lists are mutable, tuples are immutable
  - (c) Both are immutable
  - (d) Both are mutable

**Ans :**

COMP 2010

- (b) Lists are mutable, tuples are immutable

The key difference is that lists are mutable (elements can be changed after creation), whereas tuples are immutable (once created, their elements cannot be modified). This difference affects how and when each data structure is used.

- 43.** Which statement correctly describes the use of the `append()` method on a list?
- (a) It adds an element at a specific index
  - (b) It adds an element to the end of the list
  - (c) It removes an element from the list
  - (d) It sorts the list

**Ans :**

MAIN 2025

- (b) It adds an element to the end of the list

The `append()` method adds a single element to the end of a list, increasing its length by one. This is a fundamental operation for dynamically modifying lists in Python.

- 44.** Which statement is true regarding accessing elements in a tuple?
- (a) Tuples are indexed starting at 1
  - (b) Tuples use square bracket indexing similar to lists
  - (c) Tuples cannot be accessed once created
  - (d) Tuples require a special method for access

**Ans :**

SQP 2021

- (b) Tuples use square bracket indexing similar to lists

Like lists, tuples are indexed using square brackets, and indexing starts at 0. Even though tuples are immutable, their elements can be accessed in the same way as in lists.



- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are true, and the reason correctly explains the importance of a clear problem statement. The 4 Ws provide a structured approach to understanding and defining the project's requirements, guiding the entire workflow.

- 52. Assertion (A):** High-quality data acquisition is foundational for reliable AI models.

**Reason (R) :** Reliable data reduces errors and biases, ensuring better model performance.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
Both the assertion and reason are correct, and the reason explains why reliable, high-quality data is crucial. Without quality data, even the best models can produce inaccurate results, leading to poor generalization and performance.

- 53. Assertion (A):** Data exploration is vital for understanding dataset characteristics.

**Reason (R) :** Visualization techniques like histograms and scatter plots reveal trends and anomalies.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion  
Both statements are correct, and the reason properly explains the value of data exploration. Visualizing data helps in identifying patterns, outliers, and relationships that are critical for effective model selection and subsequent analysis.

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- 54. Assertion (A):** Linear regression is commonly used to predict continuous outcomes.

**Reason (R) :** It fits a linear equation to the data by modeling the relationship between variables.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
Both statements are correct, and the reason accurately explains how linear regression works. It estimates the relationship between independent and dependent variables using a linear equation, making it suitable for continuous prediction tasks.

- 55. Assertion (A):** Supervised learning relies on labeled data for training models.

**Reason (R) :** Labeled data provides ground truth that helps the algorithm learn the correct mapping from inputs to outputs.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
Both statements are correct, and the reason is the correct explanation. Supervised learning uses labeled examples to train the model, which then generalizes this mapping to new data.

- 56. Assertion (A):** Unsupervised learning discovers patterns in data without labels.

**Reason (R) :** It uses clustering and dimensionality reduction techniques to reveal hidden structures.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

45. Which statement about converting a list to a tuple is correct?

- (a) Use list() function
- (b) Use tuple() function
- (c) Use convert() function
- (d) It cannot be converted

Ans :

COMP 2023

- (b) Use tuple() function

The tuple() function converts a list into a tuple, making the collection immutable. This is useful when you need to ensure that the data cannot be changed inadvertently.

46. Which statement about the extend() method is correct?

- (a) It adds a single element to the list
- (b) It merges the elements of another iterable into the list
- (c) It removes duplicate items from the list
- (d) It sorts the list

Ans :

MAIN 2013

- (b) It merges the elements of another iterable into the list

The extend() method takes an iterable (such as another list) and appends each of its elements to the end of the original list, effectively merging the two sequences.

47. Which statement is true regarding tuple immutability?

- (a) Tuples cannot be modified once created
- (b) Tuples can be modified like lists
- (c) Tuples are mutable if they contain numbers only
- (d) Tuples can be modified using the append() method

Ans :

SQP 2019

- (a) Tuples cannot be modified once created

Tuples are immutable by design. Once a tuple is created, its elements cannot be changed, added, or removed. This property ensures that tuples remain constant throughout the program.

48. Which statement best explains the purpose of using an alias when importing a library?

- (a) It changes the library's functionality
- (b) It makes the code shorter and more readable
- (c) It imports only part of the library
- (d) It is required for all imports

Ans :

COMP 2017

- (b) It makes the code shorter and more readable

Using an alias (e.g., import numpy as np) shortens the module name, making the code cleaner and easier to read. It does not alter the functionality of the library; it simply provides a shorthand for reference.

49. Which statement about accessing list elements is correct?

- (a) The first element is accessed with index 1
- (b) The first element is accessed with index 0
- (c) Lists do not support indexing
- (d) Indexing lists returns a tuple

Ans :

MAIN 2009

- (b) The first element is accessed with index 0

Python uses zero-based indexing, meaning the first element of a list is accessed with index 0, the second with index 1, and so on.

50. Which statement best describes the relationship between modules, packages, and libraries in Python?

- (a) A module is a single file, a package is a collection of modules, and a library is a collection of packages and modules.
- (b) Modules and packages are the same, and libraries are entirely different
- (c) Libraries are a type of module only
- (d) Packages are compiled into libraries

Ans :

SQP 2006

- (a) A module is a single file, a package is a collection of modules, and a library is a collection of packages and modules.

This statement correctly describes the hierarchy: a module is a single Python file, a package is a directory of related modules (with an `__init__.py`), and a library is a collection of such packages and modules providing broad functionalities.

## ASSERTION AND REASON

51. **Assertion (A):** A well-defined problem statement is essential for an AI project.

**Reason (R) :** It uses the 4 Ws (Who, What, Where, Why) to outline objectives and affected stakeholders.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.

(a) Only statement 1 is correct.

Lists are mutable, which means their contents can be changed. Tuples, however, are immutable and cannot be altered once created.

**62.** Consider the following statements about creating lists and tuples in Python:

1. Lists are created using square brackets.
2. Tuples are created using parentheses (or even without delimiters in some cases).

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

The material shows that lists are defined with square brackets (e.g., `[1, 2, 3]`), and tuples are typically defined with parentheses (e.g., `(1, 2, 3)`) or can be created without delimiters in certain contexts.

**63.** Consider the following statements about accessing elements in lists and tuples:

1. Elements in both lists and tuples can be accessed by their index starting at 0.
2. Elements in a tuple cannot be accessed by index because tuples are immutable.

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.

Both lists and tuples allow element access via indexing (e.g., `my_list[0]` or `my_tuple[0]`). The immutability of tuples does not affect the ability to access their elements.

**64.** Consider the following statements about list operations:

1. The `append()` method adds an element to the end of a list.
2. The `insert()` method inserts an element at a specified index.

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

According to the material, `append()` adds an element to the end of the list, and `insert()` places an element at a specified index.

**65.** Consider the following statements about certain list operations:

1. The `extend()` method adds all elements of another list to the end of the current list.
2. The `sort()` method arranges the list in ascending order only.

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

(a) Only statement 1 is correct.

The `extend()` method appends elements from another list. However, the `sort()` method can arrange elements in ascending or descending order (if the `reverse` parameter is used), so stating it only sorts in ascending order is incorrect.

**66.** Consider the following statements about searching within lists:

1. The `in` operator can be used to check if an element exists in a list.
2. The `index()` method returns the index of the first occurrence of an element if it is found.

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct.

The material confirms that the `in` operator is used to check for the existence of an element and

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the `index()` method returns the position of the first occurrence of that element.

- 67.** Consider the following statements about tuples:
1. Tuples are immutable, meaning once they are created, their elements cannot be modified.
  2. You can delete individual elements of a tuple using the `del` keyword.

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Tuples are immutable, so their elements cannot be altered. The material states that while you can delete an entire tuple using `del`, you cannot delete individual elements.

- 68.** Consider the following statements about converting between lists and tuples:

1. You can convert a list to a tuple using the `tuple()` function.
2. You can convert a tuple to a list using the `list()` function.

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

The material clearly explains that the `tuple()` function converts a list into a tuple and the `list()` function converts a tuple into a list.

- 69.** Consider the following statements about deletion in Python:

1. You can delete an entire tuple using the `del` keyword.
2. You can delete individual elements of a tuple using the `del` keyword.

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.

- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

While you can delete an entire tuple using `del`, the immutability of tuples means you cannot remove individual elements from them.

- 70.** Consider the following statements regarding when to use lists versus tuples:

1. Lists are ideal when you need a mutable, ordered collection where elements might be added or removed.
2. Tuples, being immutable and faster, are suitable for fixed data and can be used as keys in dictionaries.

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

The material states that lists are preferable when mutability is required, whereas tuples are ideal for fixed data, offer performance benefits due to immutability, and can be used as keys in dictionaries.

## PICTURE BASED QUESTIONS

- 71.** An image shows a Python list `my_list = [1, 2, 3, "apple", "banana"]` with different data types. What type of collection is this?



- (a) Dictionary
- (b) Tuple
- (c) List
- (d) Set

Ans :

- (c) List

A list in Python is an ordered, mutable collection that can store elements of different data types, such as numbers and strings. Lists are defined using square brackets [].

72. An image shows a Python list before and after using append(), insert(), and extend(). Which of the following operations is NOT modifying the list in place?



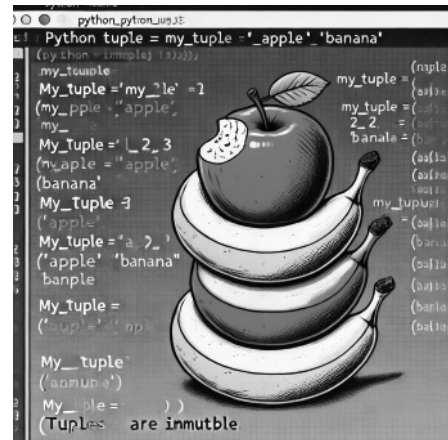
- (a) append()
- (b) insert()
- (c) extend()
- (d) sorted()

Ans :

- (d) sorted()

While append(), insert(), and extend() modify the list in place, sorted() returns a new sorted list without changing the original list. The .sort() method, however, modifies the list in place.

73. An image displays a tuple my\_tuple = (1, 2, 3, "apple", "banana") and an attempt to modify its elements. What will happen?



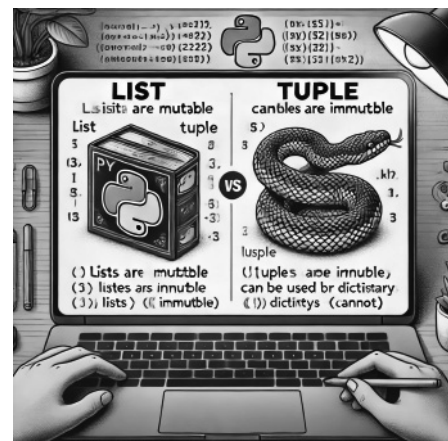
- (a) The element will change successfully.
- (b) An error will occur.
- (c) The tuple will automatically convert into a list.
- (d) The change will be stored in a temporary copy.

Ans :

- (b) An error will occur.

Tuples are immutable, meaning their elements cannot be modified once created. Attempting to change an element in a tuple will result in a TypeError.

74. An image shows a comparison between a list and a tuple containing the same elements. What is a key reason to use a tuple instead of a list?



- (a) Tuples are mutable.
- (b) Tuples are faster and can be used as dictionary keys.
- (c) Lists are faster than tuples.
- (d) Lists consume less memory than tuples.

Ans :

- (b) Tuples are faster and can be used as dictionary keys.

Both statements are true, and the reason accurately describes unsupervised learning's approach. Without labels, it finds inherent patterns through methods like clustering or PCA, which is useful for exploratory data analysis.

**57. Assertion (A):** Acquiring data from reliable sources is critical for model accuracy.

**Reason (R) :** Quality data minimizes bias and errors, leading to more robust and generalizable models.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are correct, and the reason is the correct explanation. Reliable data is essential to prevent the propagation of errors and biases, ensuring that the model learns accurate representations.

**58. Assertion (A):** Bar graphs and histograms are effective tools for data visualization.

**Reason (R) :** They help display data distribution and frequency, highlighting trends and outliers.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are correct, and the reason explains why these visualization techniques are valuable. They provide insights into data distribution, which is crucial for understanding and preparing data for modelling.

**59. Assertion (A):** Rule-based approaches in AI are less flexible than learning-based methods.

**Reason (R) :** Rule-based systems use fixed if-then conditions and cannot adapt to new data without manual changes.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are correct, and the reason correctly explains the rigidity of rule-based systems compared to learning-based approaches, which can update and improve with new data.

**60. Assertion (A):** The Kaggle platform is valuable for accessing diverse AI datasets.

**Reason (R) :** It offers curated datasets and competitions that encourage learning and benchmarking.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are true, and the reason correctly explains Kaggle's benefits. It provides high-quality data and practical challenges, which are instrumental in both learning and advancing AI projects.

## STATEMENT BASED QUESTIONS

**61.** Consider the following statements about Python lists and tuples:

1. Lists are mutable, meaning you can change their contents after creation.
2. Tuples are mutable, so you can change their contents after creation.

Which of the statements above is/are correct?

Please select the correct option from the list below:

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

**88.** Why are tuples considered immutable?

**Ans :** MAIN 2011  
Once created, the elements of a tuple cannot be modified, added, or removed.

**89.** What is the result of `my_list.append(5)` on `[1, 2, 3]`?

**Ans :** SQP 2014  
The list becomes `[1, 2, 3, 5]`.

**90.** How is a tuple different from a list?

**Ans :** COMP 2017  
Tuples are immutable (unchangeable), while lists are mutable (changeable).

**91.** What file extension do Python modules have?

**Ans :** MAIN 2025  
Python modules have the `.py` extension.

**92.** Why might you convert a list to a tuple?

**Ans :** SQP 2023  
To ensure the data remains constant and cannot be modified accidentally.

**93.** What does negative indexing do in Python lists?

**Ans :** COMP 2021  
It accesses elements from the end of the list (e.g., `my_list[-1]` returns the last element).

**94.** Name one benefit of using aliases when importing libraries.

**Ans :** MAIN 2024  
Aliases shorten code and make it more readable.

**95.** What is the role of the `__init__.py` file in a package?

**Ans :** SQP 2013  
It signals that the directory is a Python package and can include initialization code.

## THREE MARKS QUESTIONS

**96.** Explain the main differences between lists and tuples in Python.

**Ans :** MAIN 2016

Lists are mutable, meaning you can add, remove, or change elements after creation, while tuples are immutable, so their contents cannot be altered once set. This makes lists ideal for dynamic collections and tuples suitable for fixed data.

**97.** Discuss how you would access and modify a list element in Python.

**Ans :** SQP 2015  
You access an element by its index (e.g., `list[0]`) and can modify it directly by assignment (e.g., `list[0] = new_value`). This direct indexing and modification is a key feature of Python lists.

**98.** Describe a scenario where converting a list to a tuple might be useful.

**Ans :** COMP 2019  
When you want to ensure that the data remains constant and is not modified later, such as storing configuration parameters or fixed data values, converting the list to a tuple guarantees immutability.

**99.** How would you search for an element in a list?

**Ans :** MAIN 2006  
You can search for an element using the `in` operator to check for membership or the `index()` method to retrieve its position. This allows you to verify if the element exists and find its location within the list.

**100.** What is the purpose of the `extend()` method in a list, and how does it differ from `append()`?

**Ans :** SQP 2012  
The `extend()` method adds each element from an iterable (like another list) to the current list, while `append()` adds the entire iterable as a single element at the end. This makes `extend()` suitable for merging lists.

**101.** Explain how you would sort a list of numbers in ascending order.

**Ans :** COMP 2018  
You can sort a list of numbers by using the `sort()` method, which rearranges the list in place in ascending order. For example, `numbers.sort()` will modify the list to be in increasing numerical order.

**102.** How can you convert a tuple to a list and why might you do this?

- 11.** Which method counts the occurrences of a substring?  
 (a) find()  
 (b) count()  
 (c) index()  
 (d) search()

Ans :

SQP 2017

(b) count()

The count() method returns the number of times a particular substring appears in the string, enabling frequency analysis.

- 12.** What does string.isalpha() check?  
 (a) Whether the string contains only digits  
 (b) Whether the string contains only alphabetic characters  
 (c) Whether the string is in uppercase  
 (d) Whether the string has any whitespace

Ans :

COMP 2014

(b) Whether the string contains only alphabetic characters

The isalpha() method returns True if every character in the string is a letter, making it useful for validating inputs that should contain only letters.

- 13.** Which method returns True if all characters in the string are digits?  
 (a) isdigit()  
 (b) isnumeric()  
 (c) isalnum()  
 (d) isalpha()

Ans :

MAIN 2011

(a) isdigit()

The isdigit() method checks if every character in the string is a digit and returns True if so, otherwise False. This is essential for input validation of numeric strings.

- 14.** What does string.isalnum() do?  
 (a) Checks if a string is entirely alphabetic  
 (b) Checks if a string contains only letters and numbers  
 (c) Converts a string to alphanumeric  
 (d) Splits a string into letters and numbers

Ans :

SQP 2012

(b) Checks if a string contains only letters and numbers

The isalnum() method returns True if all characters in the string are either alphabetic or numeric, making it useful for validating inputs where no special characters or spaces are allowed.

- 15.** Which method joins an iterable of strings into one string with a separator?  
 (a) concat()  
 (b) join()  
 (c) merge()  
 (d) add()

Ans :

COMP 2018

(b) join()

The join() method concatenates the elements of an iterable (like a list) into a single string, inserting the string on which it is called as the separator between each element.

- 16.** What does the slicing expression string[start :end :step] do?  
 (a) Modifies the original string  
 (b) Returns a new substring based on specified indices and step  
 (c) Sorts the characters in the string  
 (d) Converts the string to uppercase

Ans :

MAIN 2010

(b) Returns a new substring based on specified indices and step

Slicing extracts a portion of a string starting from the start index up to, but not including, the end index, and includes every stepth character. The original string remains unchanged because strings are immutable.

- 17.** Which operator is used for string concatenation?  
 (a) -  
 (b) \*  
 (c) +  
 (d) /

Ans :

SQP 2022

(c) +

The + operator combines two strings into one, making it the standard method for string concatenation in Python.

- 18.** What is the output of "hello".upper()?  
 (a) "hello"  
 (b) "HELLO"  
 (c) "Hello"  
 (d) "hELLO"

Ans :

COMP 2008

(b) "HELLO"

The upper() method converts all alphabetic characters in the string to uppercase, so "hello" becomes "HELLO".

**114.** How can you combine two lists in Python?

**Ans :**

MAIN 2019

You can combine two lists using the + operator, e.g., `combined = list1 + list2`, which returns a new list containing the elements of both lists.

**115.** Explain why tuples can be used as dictionary keys.

**Ans :**

SQP 2016

Tuples are immutable, meaning their contents cannot change. This immutability ensures that their hash value remains constant, making them suitable for use as keys in dictionaries where keys must be immutable.

## NINE MARKS QUESTION

**116.** Write a Python program that performs the following operations on a tuple:

1. Create a tuple with the elements: (2, 4, 6, 8, 10).
2. Access and print the element at index 3.
3. Convert the tuple into a list.
4. Remove the element 6 from the list.
5. Convert the list back into a tuple.
6. Print the final tuple.

**Ans :**

MAIN 2025

Step 1: Create a tuple with the given elements

```
my_tuple = (2, 4, 6, 8, 10)
```

Step 2: Access and print the element at index 3

```
print("Element at index 3:", my_tuple[3])
```

# Output: 8

Step 3: Convert the tuple into a list

```
my_list = list(my_tuple)
```

Step 4: Remove the element 6 from the list

```
my_list.remove(6)
```

Step 5: Convert the list back into a tuple

```
final_tuple = tuple(my_list)
```

Step 6: Print the final tuple

```
print("Final tuple:", final_tuple)`
```

Expected Output:

Element at index 3: 8

Final tuple: (2, 4, 8, 10)`

**117.** Write a Python program that performs the following operations on a tuple:

1. Create a tuple with the elements:

(1, 3, 5, 7, 9).

2. Access and print the element at index 1.
3. Convert the tuple into a list.
4. Add the integer 11 to the list.
5. Convert the list back into a tuple.
6. Print the final tuple.

**Ans :**

SQP 2022

Step 1: Create a tuple with the given elements

```
my_tuple = (1, 3, 5, 7, 9)
```

Step 2: Access and print the element at index 1

```
print("Element at index 1:", my_tuple[1])
```

# Output: 3

Step 3: Convert the tuple into a list

```
my_list = list(my_tuple)
```

Step 4: Add the integer 11 to the list

```
my_list.append(11)
```

Step 5: Convert the list back into a tuple

```
final_tuple = tuple(my_list)
```

Step 6: Print the final tuple

```
print("Final tuple:", final_tuple)
```

Expected Output:

Element at index 1: 3

Final tuple: (1, 3, 5, 7, 9, 11)

**118.** Write a Python program that performs the following operations on a tuple:

1. Create a tuple with the elements: ("apple", "banana", "cherry", "date").
2. Access and print the last element.
3. Convert the tuple into a list.
4. Replace "banana" with "blueberry".
5. Convert the list back into a tuple.
6. Print the final tuple.

**Ans :**

COMP 2010

Step 1: Create a tuple with the given elements

```
my_tuple=("apple", "banana", "cherry", "date")
```

Step 2: Access and print the last element

```
print("Last element:", my_tuple[-1])
```

#Output: date

Step 3: Convert the tuple into a list

```
my_list = list(my_tuple)
```

Step 4: Replace "banana" with "blueberry"

```
my_list[1] = "blueberry"
```

Step 5: Convert the list back into a tuple

```
final_tuple = tuple(my_list)
```

Step 6: Print the final tuple

```
print("Final tuple:", final_tuple)
```

Expected Output:

Last element: date

Final tuple: ('apple', 'blueberry', 'cherry', 'date')

```
text = "Hello, World!"
substring = text[7 :12] # "World"
every_second = text[: :2] # "Hlo
ol!"
```

Slicing is powerful for retrieving substrings without altering the original string.

## 6. IN-BUILT STRING FUNCTIONS

Python provides a rich set of built-in functions and methods to manipulate strings :

1. `len(string)` : Returns the total number of characters in the string (including spaces and punctuation).

```
length = len("Hello") # 5
```

2. `string.upper()` : Converts all characters in the string to uppercase.

```
shout = "hello".upper() # "HELLO"
```

3. `string.lower()` Converts all characters in the string to lowercase.

```
whisper = "HELLO".lower() # "hello"
```

4. `string.endswith(value)` Checks if the string ends with the specified substring; returns a Boolean value.

```
result = "Python".endswith("on")
True
```

5. `string.startswith(value)` : Checks if the string starts with the specified substring.

```
result = "Python".startswith("Py")
True
```

6. `string.find(value)` Returns the lowest index of the substring if found, otherwise -1.

```
index = "Hello".find("l") # 2
```

7. `string.islower()` Returns True if all alphabetic characters in the string are lowercase.

```
is_lower = "hello".islower()
True
```

8. `string.replace(oldvalue, newvalue)` Returns a new string with all occurrences of oldvalue replaced by newvalue.

```
new_string = "hello world".replace("world", "Python") # "hello Python"
```

9. `string.count(value)` Counts the number of non-overlapping occurrences of a substring.

```
count = "banana".count("a") # 3
```

10. `string.isalpha()` Returns True if all characters in the string are alphabetic.

```
result = "hello".isalpha() # True
```

11. `string.isdigit()` : Returns True if all characters in the string are digits.

```
result = "123".isdigit() # True
```

12. `string.isalnum()` Returns True if all characters in the string are alphanumeric (letters and digits).

```
result = "abc123".isalnum() # True
```

13. `string.join(iterable)` : Joins the elements of an iterable (typically a list of strings) into a single string, using the string as a separator.

```
combined = "-".join(["2023", "04", "01"]) # "2023-04-01"
```

14. Slicing with `string[start :end :step]` : Extracts a substring from the original string based on start, end, and step parameters.

```
snippet = "Hello, World!"[7 :12] # "World"
```

## 7. WHY USE STRING FUNCTIONS?

String methods simplify complex text manipulation tasks. They :

1. Enhance code readability.
2. Provide efficient ways to clean, search, modify, and analyze text.
3. Ensure consistency in data formatting and comparisons.
4. Are essential for tasks ranging from simple data entry to processing large text datasets.

## MULTIPLE CHOICE QUESTION

1. What is a string in Python?
  - (a) A collection of numbers
  - (b) A sequence of characters
  - (c) A function
  - (d) A key-value pair structure

Ans :

MAIN 2025

- (b) A sequence of characters

A string in Python is defined as a sequence of characters enclosed in quotes. It can include letters, digits, symbols, and whitespace, and is one of the basic data types used for text manipulation.

2. How do you create a multiline string in Python?
  - (a) Use single quotes
  - (b) Use triple quotes
  - (c) Use double quotes
  - (d) Use square brackets

to a tuple using `tuple()`. This conversion process allows for controlled modifications.

- 127.** An application requires frequent addition and deletion of elements in a collection. Should the developer choose a list or a tuple, and why?

**Ans :**

The developer should choose a list because lists are mutable, allowing for efficient addition, deletion, and updating of elements. Tuples are immutable, which would require creating a new tuple every time a change is needed, making them unsuitable for dynamic data.

- 128.** A program needs to ensure that the sequence of steps in a recipe remains unchanged. What data structure should be used and why?

**Ans :**

A tuple should be used to store the recipe steps because its immutability guarantees that the sequence cannot be altered once defined. This ensures that the recipe remains consistent every time it is accessed.

- 129.** A user needs to create a complex list from multiple data sources and later verify its contents. How can Python's list operations help?

**Ans :**

The user can use `extend()` to merge data from different sources into a single list, `sort()` to arrange the data for easier verification, and the `in` operator to search for specific values. These operations make it simple to compile and verify data efficiently.

- 130.** A developer is designing a program that maintains a list of fruits which can change as new fruits are added. Should they use a list or a tuple, and how can they add a new fruit to the collection?

**Ans :**

They should use a list because lists are mutable.  
`fruits = ["apple", "banana", "orange"]`  
`fruits.append("cherry")`  
 Using a list allows the collection to be dynamically updated as new fruits become available.

- 131.** An application that handles geographical data needs to store fixed coordinate pairs (latitude and longitude) that never change. Should these be stored as lists or tuples, and why?

**Ans :**

They should be stored as a tuple because tuples are immutable and hashable.

`coordinates = (37.7749, -122.4194)`

Since the coordinates remain constant, tuples prevent accidental modifications and can be used as dictionary keys if needed.

- 132.** A program receives a list of unsorted numbers from a sensor and must output them in ascending order. Which list operation is appropriate for this task, and how is it implemented?

**Ans :**

They should use the `sort()` method to arrange the numbers.

`numbers = [3, 1, 4, 2]`

`numbers.sort()` # numbers becomes [1, 2, 3, 4]

Sorting the list in place ensures that the data is ordered efficiently for further processing.

- 133.** An inventory system needs to merge two collections of product IDs. One collection is stored in a list, and the other in another list. How can these be combined into one list?

**Ans :**

They should use the `extend()` method to merge the two lists.

`products1 = [101, 102, 103]`

`products2 = [104, 105]`

`products1.extend(products2)` # products1 becomes [101, 102, 103, 104, 105]

The `extend()` method efficiently appends all elements from the second list to the first, maintaining order.

- 134.** A to-do application requires adding a high-priority task at the beginning of a task list. Which list operation is best suited for this, and how is it performed?

**Ans :**

They should use the `insert()` method to add an element at a specific index.

`tasks = ["Complete report", "Email client"]`

`tasks.insert(0, "Fix critical bug")`

# Inserts at the beginning

Inserting at index 0 ensures that the high-priority task appears at the top of the list.

- 135.** A program needs to verify if a particular product ("apple") exists in a list of items before processing further. How can this check be performed using list operations?

**Ans :**

They can use the `in` operator to check for membership.

```
items = ["apple", "banana", "orange"]
```

if "apple" in items:

```
print("Apple is available")
```

Using the `in` operator provides a clear and efficient way to verify the presence of an element in a list.

- 136.** A developer is using configuration settings that should never change and wants to use these settings as keys in a dictionary. Should the settings be stored as a list or tuple, and why?

**Ans :**

They should be stored as a tuple because tuples are immutable and can be hashed.

```
config = (1920, 1080)
```

```
settings_dict = {config: "Display Resolution"}
```

Using a tuple ensures that the configuration remains constant and can safely be used as a key in a dictionary.

- 137.** In an application that generates reports, a list of items must be converted into an immutable format before being published. How can you convert a list to a tuple in Python?

**Ans :**

They should use the `tuple()` function to convert the list.

```
items = ["pen", "pencil", "notebook"]
```

```
items_tuple = tuple(items)
```

Converting the list to a tuple guarantees that the published report data remains unaltered.

- 138.** A developer needs to access the first element of a list and the last element of a tuple. How can this be achieved using indexing?

**Ans :**

They can access elements by their index using `list[0]` for the first element and `tuple[-1]` for the last element.

```
my_list = [1, 2, 3]
```

```
my_tuple = ("apple", "banana", "cherry")
```

```
first_element = my_list[0] # 1
```

```
last_element = my_tuple[-1] # "cherry"
```

Indexing allows for direct access to any element in the collection based on its position.

- 139.** A configuration stored as a tuple needs to be updated due to a change in one of its values. What is the recommended approach to modify a tuple's contents?

**Ans :**

They should convert the tuple to a list, modify the list, and then convert it back to a tuple.

```
settings = (10, 20, 30)
```

```
settings_list = list(settings)
```

```
settings_list[1] = 25 # Update the second value
```

```
settings = tuple(settings_list)
```

This approach allows modifications while preserving the advantages of using tuples for immutable data storage once the updates are complete.

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# CHAPTER 11

## STRINGS IN PYTHON

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### 1. STRINGS

A string in Python is an immutable sequence of characters. It can include letters, numbers, punctuation marks, and special characters. Strings are one of Python's most fundamental data types and are used to represent text data. Because strings are immutable, any modification results in the creation of a new string rather than altering the original.

### 2. CREATING STRINGS

#### 2.1 Single-line Strings

You create a single-line string by enclosing characters in single quotes ('...') or double quotes ("...").

```
greeting = "Hello, World!"
message = 'Python programming is fun.'
```

Both styles are acceptable; choose based on the need to include quotes within the string.

#### 2.2 Multiline Strings

To create strings that span multiple lines, triple quotes ("..." or "...") are used. These are especially useful for writing long texts, documentation, or preserving formatting.

```
poem = """Roses are red,
Violets are blue,
Python is cool,
And so are you."""
```

Multiline strings maintain newline characters automatically, making them ideal for preserving the original formatting.

### 3. TRAVERSING STRINGS

#### 3.1 Indexing

Each character in a string has an index, starting at 0. You can access any character by its index.

```
s = "Hello"
first_char = s[0] # 'H'
last_char = s[-1] # 'o',
using negative indexing to access from the end
```

#### 3.2 Looping Through Characters

You can loop over each character in a string using a for loop.

```
for char in s :
 print(char)
```

This is useful for performing operations on each individual character.

### 4. STRING OPERATIONS

#### 4.1 Concatenation

Strings can be joined using the + operator.

```
part1 = "Hello"
part2 = "World"
combined = part1 + ", " + part2 + "!"
"Hello, World!"
```

Concatenation is essential for building messages or combining text from different sources.

#### 4.2 Escape Sequences

Special characters in strings are represented using escape sequences, which begin with a backslash (\):

```
\r : Newline
\t : Tab
\\ : Backslash
\' or \" : Single or double quotes,
respectively
python
escaped = "First Line\rSecond Line\
tIndented"
print(escaped)
```

Escape sequences help in formatting strings in output and in maintaining readability within the code.

#### 4.3 String Operators

Concatenation (+) : Joins strings together.

Repetition () : Repeats a string a specified number of times.

```
laugh = "ha" 3 # "hahaha"
```

### 5. SLICING

Slicing allows you to extract a portion of a string using the syntax string[start :end :step].

**119.** Write a Python program that performs the following operations on a tuple:

1. Create a tuple with the elements: (10, 20, 30, 40, 50).
2. Access and print the element at index 4.
3. Convert the tuple into a list.
4. Insert the integer 25 at index 2.
5. Convert the list back into a tuple.
6. Print the final tuple.

**Ans :**

MAIN 2019

Step 1: Create a tuple with the given elements

```
my_tuple = (10, 20, 30, 40, 50)
```

Step 2: Access and print the element at index 4

```
print("Element at index 4:", my_tuple[4]) #
```

Output: 50

Step 3: Convert the tuple into a list

```
my_list = list(my_tuple)
```

Step 4: Insert the integer 25 at index 2

```
my_list.insert(2, 25)
```

Step 5: Convert the list back into a tuple

```
final_tuple = tuple(my_list)
```

Step 6: Print the final tuple

```
print("Final tuple:", final_tuple)
```

Expected Output:

Element at index 4: 50

Final tuple: (10, 20, 25, 30, 40, 50)

## CASE BASED QUESTION

**120.** A student is creating a program to manage a shopping list that can be updated over time. Explain how lists are ideal for this task.

**Ans :**

Lists are mutable and ordered, allowing the student to add, remove, or update items as needed. Functions like `append()`, `insert()`, and `remove()` make it easy to manage the list dynamically, reflecting changes in the shopping requirements.

**121.** An application requires a fixed set of configuration parameters that should not change during runtime. Which data structure is best suited for this and why?

**Ans :**

A tuple is best suited because it is immutable. Once the configuration parameters are set in a tuple, they cannot be altered during runtime, ensuring the integrity of the configuration settings

throughout the application's execution.

**122.** A developer needs to merge two lists of user data. Describe how they can accomplish this and why it is efficient.

**Ans :**

The developer can use the `extend()` method or the `+` operator to merge the lists. Using `extend()` appends each element of the second list to the first, efficiently combining the data without creating nested lists, which is both memory- and time-efficient.

**123.** A program uses a list to store student names. How would you check if "Alice" is in the list and then find her position?

**Ans :**

You can check for "Alice" using the `in` operator (e.g., "Alice" in `student_list`). If she is present, use `student_list.index("Alice")` to find her index. This method is straightforward and leverages built-in list functions.

**124.** A teacher wants to record the scores of students for an exam and then convert them into an immutable record for archival. How would you achieve this in Python?

**Ans :**

First, store the scores in a list for flexibility during the input phase. Once finalized, convert the list to a tuple using `tuple(scores)` to create an immutable record that prevents any accidental changes.

**125.** In a data analysis project, a researcher needs to sort a list of numerical values. Explain which method they should use and why.

**Ans :**

The researcher should use the `sort()` method to arrange the list in ascending order. This method modifies the list in place and efficiently orders the numbers, which is essential for tasks like finding medians or preparing data for further statistical analysis.

**126.** A developer has a tuple of constants but later realizes they need to update one value. How can they achieve this?

**Ans :**

Since tuples are immutable, the developer must convert the tuple to a list using `list()`, update the necessary element, and then convert it back

**Ans :**

SQP 2024

(b) Use triple quotes

Multiline strings are created using triple quotes (either `'''` or `"""`), which allow the string to span multiple lines while preserving newline characters, making it ideal for longer blocks of text or formatted output.

**3.** Which operator concatenates two strings?

- (a)
- (b) -
- (c) +
- (d) /

**Ans :**

COMP 2021

(c) +

The + operator is used to concatenate two strings in Python, combining them into one continuous string.

**4.** What does the escape sequence `\t` represent?

- (a) Newline
- (b) Tab
- (c) Backslash
- (d) Quote

**Ans :**

MAIN 2023

(b) Tab

The escape sequence `\t` is used to insert a horizontal tab into a string, which is useful for aligning output in text formatting.

**5.** Which function returns the number of characters in a string?

- (a) `str()`
- (b) `len(string)`
- (c) `count()`
- (d) `size()`

**Ans :**

SQP 2015

(b) `len(string)`

The `len()` function returns the total number of characters in a string, including letters, numbers, spaces, and punctuation.

**6.** What does the method `string.upper()` do?

- (a) Converts all characters to lowercase
- (b) Converts all characters to uppercase
- (c) Capitalizes only the first letter
- (d) Reverses the string

**Ans :**

COMP 2007

(b) Converts all characters to uppercase

The `upper()` method transforms all lowercase alphabetic characters in a string into their

uppercase equivalents, without altering non-alphabetic characters.

**7.** How do you check if a string ends with a specific substring?

- (a) `string.startswith(value)`
- (b) `string.endswith(value)`
- (c) `string.find(value)`
- (d) `string.count(value)`

**Ans :**

MAIN 2009

(b) `string.endswith(value)`

The `endswith()` method returns `True` if the string ends with the specified substring, making it useful for validations and conditional checks.

**8.** What does the method `string.find(value)` return if the substring is not found?

- (a) 0
- (b) `None`
- (c) -1
- (d) Raises an error

**Ans :**

SQP 2013

(c) -1

The `find()` method returns the lowest index at which the specified substring is found, or -1 if it is not present, allowing for safe searching within the string.

**9.** Which method checks if all letters in a string are lowercase?

- (a) `islower()`
- (b) `isupper()`
- (c) `isalpha()`
- (d) `lower()`

**Ans :**

COMP 2016

(a) `islower()`

The `islower()` method returns `True` if all alphabetic characters in the string are in lowercase, otherwise it returns `False`.

**10.** How do you replace a substring within a string?

- (a) `string.change(old, new)`
- (b) `string.replace(oldvalue, newvalue)`
- (c) `string.swap(old, new)`
- (d) `string.modify(old, new)`

**Ans :**

MAIN 2019

(b) `string.replace(oldvalue, newvalue)`

The `replace()` method returns a new string where all occurrences of the specified substring are replaced with another substring. It does not alter the original string due to immutability.

**Ans :**

MAIN 2011

You convert a tuple to a list using the `list()` function, e.g., `list(my_tuple)`. This is useful when you need to modify the sequence, as lists are mutable while tuples are not.

- 103.** What is negative indexing and how is it used with lists?

**Ans :**

SQP 2009

Negative indexing allows you to access elements from the end of the list, with -1 referring to the last element, -2 to the second-last, and so on. It is useful for quickly retrieving items from the end without knowing the list's length.

- 104.** Describe how the `insert()` method works with an example.

**Ans :**

COMP 2014

The `insert()` method adds an element at a specified index, shifting the subsequent elements to the right. For example, `my_list.insert(2, "new")` will insert "new" at index 2.

- 105.** Why is immutability an important property of tuples?

**Ans :**

MAIN 2007

Immutability ensures that once a tuple is created, its data cannot be changed, which is useful for maintaining data integrity. It makes tuples safe to use as dictionary keys and prevents accidental modifications.

- 106.** How would you remove an element from a list?

**Ans :**

SQP 2017

You can remove an element using the `remove()` method (which removes the first occurrence of a value) or the `pop()` method (which removes an element at a specified index and returns it). Both methods modify the list in place.

- 107.** What is the difference between the `pop()` method and the `remove()` method in lists?

**Ans :**

COMP 2010

The `pop()` method removes an element by its index and returns it, while `remove()` deletes the first occurrence of a specified value without returning it. This distinction is important depending on whether you need the removed element for further processing.

- 108.** How would you search for an element in a tuple?

**Ans :**

MAIN 2008

Although tuples are immutable, you can still search for an element using the `in` operator, e.g., "apple" in `my_tuple`, or by using the `index()` method to find its position.

- 109.** Explain the concept of mutability in Python with respect to lists and tuples.

**Ans :**

SQP 2022

Mutability means that an object's content can be changed after it is created. Lists are mutable, so you can add, remove, or modify elements, whereas tuples are immutable, which means that once they are created, their content remains constant.

- 110.** What is the purpose of converting a tuple to a list?

**Ans :**

COMP 2021

Converting a tuple to a list makes it possible to modify the sequence (add, remove, or change elements). This is useful when you need a flexible data structure for further manipulation that the immutable tuple does not allow.

- 111.** How does the `sort()` method affect a list?

**Ans :**

MAIN 2024

The `sort()` method rearranges the elements of the list in place into ascending order by default. It does not return a new list; instead, it modifies the original list.

- 112.** Describe how you would create a list of integers from 1 to 5 using Python.

**Ans :**

SQP 2025

You can create a list of integers using a literal list or a range function.

For example,  
`my_list = [1, 2, 3, 4, 5]`

**or**

`my_list = list(range(1, 6))` creates a list from 1 to 5.

- 113.** What is the significance of the square bracket notation in Python?

**Ans :**

COMP 2015

Square brackets are used to define lists and access elements within them by index. They are fundamental to Python's syntax for creating ordered, mutable collections.

**19.** What does "Python".startswith("Py") return?

- (a) False
- (b) True
- (c) "Py"
- (d) None

**Ans :**

MAIN 2025

- (b) True

The startswith() method checks if the string begins with the specified substring. Since "Python" starts with "Py", it returns True.

**20.** If s = "data", what does s.count("a") return?

- (a) 0
- (b) 1
- (c) 2
- (d) 3

**Ans :**

SQP 2010

- (c) 2

The count() method counts how many times the specified substring appears in the string. In "data", the letter "a" appears twice, so it returns 2.

**21.** Which function returns the length of a string?

- (a) str()
- (b) len()
- (c) count()
- (d) size()

**Ans :**

COMP 2023

- (b) len()

The len() function returns the total number of characters in a string, including spaces and punctuation.

**22.** What is the output of "hello".replace("l", "z")?

- (a) "hezzo"
- (b) "hezzo"
- (c) "hello"
- (d) "hezlo"

**Ans :**

MAIN 2022

- (a) "hezzo"

The replace() method substitutes all occurrences of the specified substring ("l") with another ("z"). In "hello", all "l" characters become "z", resulting in "hezzo".

**23.** Which method checks if all letters in a string are lowercase?

- (a) islower()
- (b) isupper()
- (c) isalpha()

- (d) lower()

**Ans :**

SQP 2024

- (a) islower()

The islower() method returns True if every alphabetic character in the string is in lowercase. Otherwise, it returns False.

**24.** How do you extract every second character from a string s?

- (a) s[:2]
- (b) s[1:2]
- (c) s[:1]
- (d) s[0:2]

**Ans :**

COMP 2008

- (a) s[:2]

The slicing expression s[:2] selects every second character from the string starting from index 0. This is achieved by using a step of 2 in the slice notation.

**25.** Which expression returns True if all characters in "test" are lowercase?

- (a) "test".islower()
- (b) "test".isupper()
- (c) "test".isalpha()
- (d) "test".isnumeric()

**Ans :**

MAIN 2021

- (a) "test".islower()

Since every alphabetic character in "test" is in lowercase, the islower() method returns True.

**26.** Which method checks if a string contains only alphabetic characters?

- (a) isdigit()
- (b) isalpha()
- (c) isalnum()
- (d) islower()

**Ans :**

SQP 2013

- (b) isalpha()

The isalpha() method returns True if every character in the string is a letter, and False otherwise. It does not consider numbers or other characters.

**27.** What does "123".isdigit() return?

- (a) True
- (b) False
- (c) "123"
- (d) None

**Ans :**

COMP 2014

(a) True

The `isdigit()` method checks whether all characters in the string are digits. Since "123" contains only digits, it returns True.

**28.** What does "Hello".`isalnum()` check for?

- (a) Only letters
- (b) Only digits
- (c) Only alphanumeric characters (letters and numbers) with no spaces or symbols
- (d) Any characters

**Ans :**

MAIN 2015

(c) Only alphanumeric characters (letters and numbers) with no spaces or symbols

The `isalnum()` method returns True if every character in the string is either a letter or a number. It returns False if there are spaces or special symbols present.

**29.** How do you join the list ['a', 'b', 'c'] into a single string with no separators?

- (a) `",".join(['a', 'b', 'c'])`
- (b) `".join(['a', 'b', 'c'])`
- (c) `' '.join(['a', 'b', 'c'])`
- (d) `'+'.join(['a', 'b', 'c'])`

**Ans :**

SQP 2017

(b) `".join(['a', 'b', 'c'])`

The `join()` method concatenates the elements of an iterable using the string on which it is called as the separator. An empty string (") means that there will be no separator, resulting in "abc".

**30.** What is the effect of the slicing expression `s[start :end :step]` on a string?

- (a) It returns a new string with characters from index start to end (excluding end) taking every stepth character.
- (b) It modifies the original string
- (c) It converts the string to a list
- (d) It reverses the string only

**Ans :**

COMP 2006

(a) It returns a new string with characters from index start to end (excluding end) taking every stepth character.

Slicing using `s[start :end :step]` returns a new string that is a subsequence of the original string, starting at the index start, ending before end, and including every stepth character. The original string remains unchanged.

**31.** A beginner wants to modify a greeting string after creation.

Which property of Python strings is most relevant here?

- (a) Mutability
- (b) Immutability
- (c) Dynamism
- (d) Volatility

**Ans :**

MAIN 2016

(b) Immutability

In this scenario, the beginner attempts to change a greeting string. However, because Python strings are immutable, any modification creates a new string rather than altering the original. This property preserves the initial value and ensures data integrity, requiring developers to assign modifications to a new variable consistently during program execution.

**32.** A developer needs to store a poem spanning several lines while preserving newline characters.

Which technique should they use to create such a string?

- (a) Single quotes
- (b) Double quotes
- (c) Triple quotes
- (d) Backticks

**Ans :**

SQP 2018

(c) Triple quotes

In this scenario, the developer requires a multi-line string that retains formatting and newline characters. Using triple quotes (""" or """) enables the creation of strings spanning multiple lines. This method automatically preserves line breaks and whitespace, making it ideal for documentation, poems, or any text where original formatting is essential.

**33.** A programmer wishes to retrieve the first character from the string `"Hello"`.

Which index should be used?

- (a) 1
- (b) -1
- (c) 0
- (d) 2

**Ans :**

COMP 2015

(c) 0

In this case, the programmer accesses the string `"Hello"` to retrieve its first character. Python uses zero-based indexing, meaning the first element is at index 0. This consistent indexing

approach is essential for accurate element retrieval and manipulation, ensuring reliable data handling in string operations and error-free performance in practice.

- 34.** A programmer intends to print each character of the string `"Python"` on a separate line. Which control structure is most appropriate for this task?
- While loop
  - For loop
  - If statement
  - Recursion

Ans :

MAIN 2012

- (b) For loop

In this scenario, the programmer uses a for loop to iterate over each character in the string `"Python"`. Looping directly over the string allows accessing every individual character sequentially. This technique is efficient for performing operations on each element, such as printing, modifying, or analyzing characters in the string effectively.

- 35.** A developer needs to combine `"Hello"` and `"World"` with a comma and space to form `"Hello, World!"`. Which operator is used for this task?
- - 
  - /
  - +

Ans :

SQP 2021

- (d) +

In this scenario, the developer concatenates two strings using the `+` operator. Concatenation merges strings by joining them together. By combining `"Hello"`, a comma, a space, and `"World"`, the code constructs the desired output. This operator is fundamental for building dynamic messages and textual outputs in Python, efficient and reliable.

- 36.** A programmer wants to include a newline within a printed message without splitting the code line. Which escape sequence is used?
- `\t`
  - `\\`
  - `\r`
  - `\n`

Ans :

COMP 2023

- (c) `\n`

In this scenario, the programmer uses the escape sequence `\n` to insert a newline within a string. Escape sequences allow special characters, such as newlines and tabs, to be represented within strings. This method ensures proper formatting of output, preserving readability and structure without breaking the code's layout as required.

- 37.** A developer intends to generate a laughing sound by repeating `"ha"` three times.

Which operator is used to achieve this?

- +
- 
- 
- /

Ans :

MAIN 2025

- (c)

In this scenario, the developer employs the repetition operator `()` to duplicate the string `"ha"` three times, resulting in `"hahaha"`. Repetition allows a string to be repeated a specified number of times, producing a new string. This operator simplifies creating repetitive patterns without manual concatenation or looping in code efficiently.

- 38.** A programmer slices the string `"Hello, World!"` to extract `"World"`.

Which slicing parameters yield the correct substring?

- `[7 :12]`
- `[7 :13]`
- `[6 :12]`
- `[6 :13]`

Ans :

SQP 2021

- (a) `[7 :12]`

In this scenario, the programmer employs slicing to extract a portion of the string `"Hello, World!"`. By specifying the slice `[7 :12]`, the code retrieves the substring `"World"`. Slicing provides a powerful means to access specific segments of a string without altering the original content, facilitating efficient data manipulation very effectively.

- 39.** A developer calls `"hello".upper()` on the string `"hello"`.

What is the expected output?

- hello
- Hello
- HELLO
- HeLLo

Ans :

COMP 2023

(c) HELLO

In this scenario, the developer uses the upper() method on the string `"hello"`. The method converts all lowercase characters to uppercase, resulting in `"HELLO"`. This built-in function is essential for standardizing text, enabling case-insensitive comparisons and ensuring consistent data formatting across applications and various string manipulation tasks effectively every time.

40. A data scientist needs to join the list `["2023", "04", "01"]` using hyphens to create a date string. Which method should be used?

- (a) split()
- (b) join()
- (c) replace()
- (d) concat()

Ans :

MAIN 2013

(b) join()

In this scenario, the data scientist employs the join() method to concatenate elements of a list into a single string using a hyphen as a separator. This approach efficiently merges multiple string elements, producing the desired formatted date string. The join() method is crucial for combining iterable string data seamlessly.

41. Which statement best describes the purpose of lists in Python?

- (a) Lists store immutable data.
- (b) Lists store mutable, ordered collections of items.
- (c) Lists store key-value pairs only.
- (d) Lists cannot be modified once created.

Ans :

SQP 2016

(b) Lists store mutable, ordered collections of items.

Lists are designed to hold an ordered collection of elements that can be modified—items can be added, removed, or altered. This mutability makes lists versatile for dynamic data manipulation, unlike tuples, which are immutable and fixed once created.

42. Which statement best describes the difference between lists and tuples?

- (a) Lists are immutable, tuples are mutable.
- (b) Lists are mutable, tuples are immutable.
- (c) Both are immutable.
- (d) Both are mutable.

Ans :

COMP 2015

(b) Lists are mutable, tuples are immutable.

The key difference is that lists can be modified after creation, whereas tuples cannot. This property of immutability makes tuples suitable for data that should not change and for using as dictionary keys, while lists are preferred when the collection of data needs to be updated.

43. Which statement correctly describes the use of the append() method on a list?

- (a) It adds an element at a specific index.
- (b) It adds an element to the end of the list.
- (c) It removes an element from the list.
- (d) It sorts the list.

Ans :

MAIN 2019

(b) It adds an element to the end of the list.

The append() method adds a single element to the end of a list, increasing its size by one. This operation is crucial for dynamically growing lists without affecting the order of existing elements.

44. Which statement is true regarding accessing elements in a tuple?

- (a) Tuples are indexed starting at 1.
- (b) Tuples use square bracket indexing similar to lists.
- (c) Tuples cannot be accessed once created.
- (d) Tuples require a special method for access.

Ans :

SQP 2006

(b) Tuples use square bracket indexing similar to lists.

Tuples, like lists, are indexed using square brackets, and indexing begins at 0. This allows you to retrieve any element by its position even though tuples themselves are immutable.

45. Which statement about converting a list to a tuple is correct?

- (a) Use the list() function.
- (b) Use the tuple() function.
- (c) Use the convert() function.
- (d) It cannot be converted.

Ans :

COMP 2012

(b) Use the tuple() function.

The built-in tuple() function converts an iterable (like a list) into an immutable tuple. This conversion is useful when you want to ensure that the data cannot be altered once set.

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46. Which statement about the `extend()` method is correct?

- (a) It adds a single element to the list.
- (b) It merges the elements of another iterable into the list.
- (c) It removes duplicate items from the list.
- (d) It sorts the list.

Ans :

MAIN 2018

(b) It merges the elements of another iterable into the list.

The `extend()` method appends each element from the provided iterable to the end of the list, effectively merging the two lists. This is different from `append()`, which adds the entire iterable as a single element.

47. Which statement is true regarding tuple immutability?

- (a) Tuples cannot be modified once created.
- (b) Tuples can be modified like lists.
- (c) Tuples are mutable if they contain numbers only.
- (d) Tuples can be modified using the `append()` method.

Ans :

SQP 2011

(a) Tuples cannot be modified once created.

Tuples are immutable, meaning that once a tuple is created, its elements cannot be altered, added, or removed. This ensures data integrity and allows tuples to be used as keys in dictionaries.

48. Which statement best explains the purpose of using an alias when importing a library?

- (a) It changes the library's functionality.
- (b) It makes the code shorter and more readable.
- (c) It imports only part of the library.
- (d) It is required for all imports.

Ans :

COMP 2009

(b) It makes the code shorter and more readable. Using an alias (e.g., `import numpy as np`) shortens the reference to the library, making code easier to read and write. This practice is common for frequently used libraries and improves code clarity without altering functionality.

49. Which statement about accessing list elements is correct?

- (a) The first element is accessed with index 1.
- (b) The first element is accessed with index 0.
- (c) Lists do not support indexing.
- (d) Indexing lists returns a tuple.

Ans :

MAIN 2014

(b) The first element is accessed with index 0.

Python uses zero-based indexing, meaning the first element in a list is at index 0, the second at index 1, and so forth. This is a fundamental concept for accessing and manipulating list elements.

50. Which statement best describes the relationship between modules, packages, and libraries?

- (a) A module is a single file, a package is a collection of modules, and a library is a collection of packages and modules.
- (b) Modules and packages are the same, and libraries are entirely different.
- (c) Libraries are written in C only, not Python.
- (d) Modules and packages are only used for data visualization.

Ans :

SQP 2007

(a) A module is a single file, a package is a collection of modules, and a library is a collection of packages and modules.

The hierarchy is as follows : a module is a single Python file, a package is a directory of modules that includes an `__init__.py` file, and a library is a collection of such packages and modules that provide various functionalities.

## ASSERTION AND REASON

51. **Assertion (A)** : A well-defined problem statement is essential for any AI project.

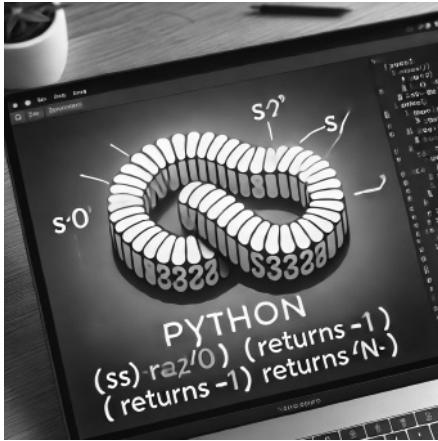
**Reason (R)** : It outlines the project's objectives, scope, and the key factors affecting the problem using the 4 Ws.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

Ans :

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both statements are correct, and the reason directly explains the assertion. A clear problem statement provides direction by using the 4 Ws (Who, What, Where, Why), which is crucial for setting project objectives and ensuring all stakeholders understand the project's scope.



- (a) List Slicing
- (b) String Indexing
- (c) Tuple Iteration
- (d) String Concatenation

**Ans :**

- (b) String Indexing

Strings in Python are indexed starting from 0. `s[0]` accesses the first character, while `s[-1]` accesses the last character using negative indexing.

- 73.** An image shows the string “hello world” being converted into uppercase using `string.upper()`. What will the output be?



- (a) “HELLO WORLD”
- (b) “hello world”
- (c) “Hello World”
- (d) “Hello world”

**Ans :**

- (a) “HELLO WORLD”

The `.upper()` method converts all letters to uppercase, making “hello world” → “HELLO WORLD”.

## TWO MARKS QUESTIONS

- 74.** Define a Python list.

**Ans :**

MAIN 2025

A list is an ordered, mutable collection of items enclosed in square brackets.

- 75.** How do you create a list in Python?

**Ans :**

SQP 2021

By placing comma-separated values inside square brackets, e.g., `[1, 2, 3]`.

- 76.** What is a tuple in Python?

**Ans :**

COMP 2017

A tuple is an ordered, immutable collection of items, defined with parentheses.

- 77.** How do you access the first character of a string `s`?

**Ans :**

MAIN 2010

Use `s[0]` to access the first character.

- 78.** Name one list operation that adds an element.

**Ans :**

SQP 2008

The `append()` method adds an element to the end of a list.

- 79.** Name one method to insert an element at a specific index in a list.

**Ans :**

COMP 2022

The `insert()` method allows inserting an element at a specified index.

- 80.** What does the `extend()` method do?

**Ans :**

MAIN 2024

It appends each element from an iterable to the list.

- 81.** How can you sort a list in place?

**Ans :**

SQP 2023

Use the `sort()` method to arrange the list in ascending order.

- 82.** How do you check if “apple” is in `my_list`?

**Ans :**

COMP 2022

Use `"apple" in my_list`.

**Reason (R) :** High-quality data minimizes bias and errors, leading to more robust and generalizable models.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both the assertion and the reason are correct, and the reason explains that data quality directly impacts model performance. Reliable data ensures that the model learns accurate patterns and avoids propagation of errors or biases.

- 58. Assertion (A) :** Bar graphs and histograms are effective tools for data visualization.

**Reason (R) :** They display data distributions and frequencies, making it easier to identify trends and outliers.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are correct, and the reason correctly explains the utility of these visualizations. They help analysts understand the underlying distribution of data, which is essential for effective data analysis and subsequent model selection.

- 59. Assertion (A) :** Rule-based approaches in AI are less flexible than learning-based methods.

**Reason (R) :** Rule-based systems use fixed if-then conditions and cannot adapt automatically to new data.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and

Reason is the correct explanation of Assertion. Both statements are true, and the reason explains the rigidity of rule-based approaches. Unlike learning-based methods that adjust to new data, rule-based systems require manual updating when conditions change, reducing their flexibility.

- 60. Assertion (A) :** The Kaggle platform is valuable for accessing diverse AI datasets.

**Reason (R) :** It offers curated datasets and competitions that promote learning, innovation, and benchmarking in AI.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion. Both statements are correct, and the reason accurately explains Kaggle's value. Kaggle provides access to a wide range of high-quality datasets and challenges, making it an essential resource for both learning and advancing AI research.

## STATEMENT BASED QUESTIONS

- 61.** Consider the following statements about Python strings :

1. Single quotes ('...') and double quotes ("...") can both be used to define single-line strings in Python.
2. Triple quotes ('''...' or '''...''') preserve formatting and allow creation of multiline strings.

Which of the statements above is/are correct?

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

(c) Both statements 1 and 2 are correct. The text clearly states that single or double quotes can define single-line strings, and triple quotes are used for multiline strings while preserving formatting.

**52. Assertion (A) :** High-quality data acquisition is foundational for building effective AI models.

**Reason (R) :** Reliable and relevant data minimizes errors and biases during model training and evaluation.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both the assertion and the reason are correct, and the reason explains why quality data is critical. With accurate and unbiased data, models can learn true patterns, leading to more reliable and generalizable predictions.

**53. Assertion (A) :** Data exploration is vital for understanding the underlying patterns of a dataset.

**Reason (R) :** Visualization techniques like histograms and scatter plots reveal trends, outliers, and correlations in the data.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both statements are true, and the reason correctly explains the value of data exploration. Visual representations help identify essential data characteristics, which guide subsequent decisions in model selection and feature engineering.

**54. Assertion (A) :** Linear regression is commonly used to predict continuous outcomes.

**Reason (R) :** It models the relationship between independent and dependent variables by fitting a straight line to the data.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both statements are correct, and the reason explains how linear regression works. By fitting a straight line, the model quantifies the relationship between variables, making it a popular choice for forecasting numerical values.

**55. Assertion (A) :** Supervised learning relies on labeled data for training models.

**Reason (R) :** Labeled data provides ground truth that the model uses to learn the mapping between inputs and outputs.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both statements are correct, and the reason is the correct explanation. In supervised learning, labels are essential for training as they guide the algorithm to predict the correct output, making accurate learning possible.

**56. Assertion (A) :** Unsupervised learning discovers patterns in data without labels.

**Reason (R) :** It uses clustering and dimensionality reduction techniques to reveal hidden structures within the data.

- (a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.
- (b) Both Assertion and Reason are correct, but Reason is not the correct explanation.
- (c) Assertion is correct, but Reason is incorrect.
- (d) Assertion is incorrect, but Reason is correct.

**Ans :**

(a) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

Both statements are true, and the reason accurately describes unsupervised learning's process. Without relying on labeled data, unsupervised methods uncover inherent patterns, which is useful for exploratory data analysis and understanding data distribution.

**57. Assertion (A) :** Acquiring data from reliable sources is critical for model accuracy.

or `False` based on whether the string ends with the given substring. However, `count(value)` returns the number of `_non-overlapping_` occurrences, making statement 2 incorrect.

- 68.** Consider the following statements about the `find()` method in Python strings :
1. `string.find(value)` returns the lowest index of `value` in the string or `-1` if not found.
  2. `string.find(value)` raises a `ValueError` exception if `value` is not found.

Which of the statements above is/are correct?

- Only statement 1 is correct.
- Only statement 2 is correct.
- Both statements 1 and 2 are correct.
- Neither statement 1 nor 2 is correct.

Ans :

- (a) Only statement 1 is correct.

The text states that `.find()` returns `-1` if the substring is not found. It does `_not_` raise a ``ValueError``.

- 69.** Consider the following statements about the string methods ``isdigit()`` and ``isalnum()`` :
1. ``string.isdigit()`` returns ``True`` if all characters in the string are digits.
  2. ``string.isalnum()`` returns ``True`` even if the string contains special characters like an underscore ``_``.

Which of the statements above is/are correct?

- (a) Only statement 1 is correct.  
(b) Only statement 2 is correct.  
(c) Both statements 1 and 2 are correct.  
(d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Explanation : The text confirms that `.isdigit()` checks if all characters are digits. The `.isalnum()` method returns `False` if there are any non-alphanumeric characters (such as underscores), so statement 2 is incorrect.

- 70.** Consider the following statements about string methods in Python :
1. ``string.join(iterable)`` concatenates the elements of an iterable (like a list of strings) into a single string, using the original string as a separator.
  2. The ``replace(oldvalue, newvalue)`` method modifies the existing string in place by replacing all occurrences of ``oldvalue`` with ``newvalue``.

Which of the statements above is/are correct?

- Only statement 1 is correct.
- Only statement 2 is correct.
- Both statements 1 and 2 are correct.
- Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

The text indicates that ``string.join(iterable)`` merges an iterable of strings into one string using the original string as a separator. However, since strings are immutable, ``replace(oldvalue, newvalue)`` returns a new string and does `_not_` modify the original string in place.

## PICTURE BASED QUESTIONS

71. An image shows a Python variable storing “Hello, World!” with labels indicating that it is a sequence of characters. What data type does this represent?



- (a) List
- (b) Tuple
- (c) String
- (d) Dictionary

**Ans :**

- (c) String

A string in Python is an immutable sequence of characters enclosed in either single (‘...’) or double (“...”) quotes. The example “Hello, World!” represents a string.

- 72.** An image shows the string `s = "Python"` and highlights `s[0]` returning `"P"` and `s[-1]` returning `"n"`. What concept does this demonstrate?

**62.** Consider the following statements about Python strings :

1. Python strings are mutable, so modifying a character updates the string in place.
2. The text specifies that any modification to a string results in a new string being created.

Which of the statements above is/are correct?

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (b) Only statement 2 is correct.

The text emphasizes that strings in Python are `__immutable__`, so any change creates a new string. Statement 1 is incorrect.

**63.** Consider the following statements about indexing in Python strings :

1. In Python, the first character of a string `s` can be accessed via `s[0]`.
2. Negative indexing is not supported in Python, so you cannot access characters from the end.

Which of the statements above is/are correct?

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

The text confirms that indexing starts at 0 for the first character. Negative indexing `__is__` possible (e.g., `s[-1]`), so statement 2 is false.

**64.** Consider the following statements about string operators in Python :

1. The repetition operator (````) can be used to repeat a string a specified number of times.
2. The `+` operator concatenates two or more strings into one.

Which of the statements above is/are correct?

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (c) Both statements 1 and 2 are correct.

The text shows examples of `laugh = "ha" * 3` for repetition and using `+` for string concatenation.

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**65.** Consider the following statements about escape sequences in Python strings :

1. `\\r`, `\\t`, and `\\\\` are examples of common escape sequences in Python.
2. According to the text, escape sequences only work inside triple-quoted strings.

Which of the statements above is/are correct?

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

Escape sequences (e.g., newline, tab) can be used in `__any__` string, not just in triple-quoted strings, so statement 2 is incorrect.

**66.** Consider the following statements about slicing strings in Python :

1. Slicing a string with the syntax `string[start :end :step]` returns a new substring without altering the original.
2. Slicing can only extract characters contiguously (i.e., you cannot skip characters).

Which of the statements above is/are correct?

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

The text states that slicing creates a new substring from the original without modifying it. You `__can__` skip characters by using the `step` parameter (for example, `text[:2]`), so statement 2 is incorrect.

**67.** Consider the following statements about built-in string methods in Python :

1. `string.endswith(value)` returns a Boolean indicating if a string ends with a specified substring.
2. `string.count(value)` returns the number of `__overlapping__` occurrences of `value`.

Which of the statements above is/are correct?

- (a) Only statement 1 is correct.
- (b) Only statement 2 is correct.
- (c) Both statements 1 and 2 are correct.
- (d) Neither statement 1 nor 2 is correct.

**Ans :**

- (a) Only statement 1 is correct.

The text confirms that `endswith` returns `True`

**83.** How do you convert a list to a tuple?

**Ans :** MAIN 2019  
By using `tuple(my_list)`.

**84.** How do you convert a tuple to a list?

**Ans :** SQP 2013  
Use `list(my_tuple)`.

**85.** What happens when you try to modify a tuple?

**Ans :** COMP 2016  
An error is raised because tuples are immutable.

**86.** What is the result of `my_list.append(5)` on `[1, 2, 3]`?

**Ans :** MAIN 2015  
The list becomes `[1, 2, 3, 5]`.

**87.** How do you access the last element of a list?

**Ans :** SQP 2006  
Use negative indexing : `my_list[-1]`.

**88.** What is the purpose of the slicing syntax `s[start :end :step]`?

**Ans :** COMP 2012  
It returns a new substring from `s`, starting at `start`, ending before `end`, taking every `step`th character.

**89.** What does `"python".islower()` return?

**Ans :** MAIN 2018  
It returns `True` because all letters in `"python"` are lowercase.

**90.** How do `upper()` and `lower()` differ?

**Ans :** SQP 2011  
`upper()` converts all letters to uppercase; `lower()` converts all letters to lowercase.

**91.** What is the output of `"data".count("a")`?

**Ans :** COMP 2009  
It returns `2`, as `"a"` appears twice.

**92.** How can you verify that a string contains only letters?

**Ans :** MAIN 2014  
Use the `isalpha()` method.

**93.** Explain how the `join()` method works with an example.

**Ans :** SQP 2017  
`join()` concatenates elements of an iterable using the string as a separator. For example, `"-"`. `join(["a", "b", "c"])` returns `"a-b-c"`.

## THREE MARKS QUESTIONS

**94.** Discuss the importance of string immutability in Python.

**Ans :** MAIN 2025  
String immutability ensures that once created, a string's content cannot be altered, which maintains data integrity and security. This property allows strings to be used as dictionary keys and shared safely across different parts of a program, preventing accidental modifications.

**95.** Explain how you can traverse a string in Python.

**Ans :** SQP 2021  
You can traverse a string using indexing (e.g., `s[0]`, `s[1]`, etc.) or by iterating over it with a for loop. This allows you to process each character individually for tasks such as searching, counting, or applying transformations.

**96.** How do escape sequences enhance string handling in Python?

**Ans :** COMP 2023  
Escape sequences allow you to insert special characters like newlines (`\n`), tabs (`\t`), or quotes within a string. They provide a method to include characters that would otherwise be difficult to type or would conflict with the string's delimiter.

**97.** Describe the process and benefit of concatenating strings.

**Ans :** MAIN 2024  
Concatenation involves using the `+` operator to join two or more strings into one. This is beneficial for dynamically constructing messages, combining data from multiple sources, and formatting output without needing to manually type long strings.

**98.** What is string slicing and why is it useful?

**Ans :** SQP 2013  
String slicing, using the syntax `s[start :end :step]`, extracts a substring from a larger string. It is

useful for retrieving specific parts of a string, such as extracting a date from a timestamp or reversing a string, without modifying the original value.

- 99.** Compare and contrast the `append()` and `extend()` methods for lists.

**Ans :**

COMP 2016

The `append()` method adds a single element to the end of a list, whereas the `extend()` method takes an iterable and adds each of its elements to the list. `append()` is used for adding one item at a time, while `extend()` is ideal for merging lists.

- 100.** How can converting a list to a tuple be beneficial?

**Ans :**

MAIN 2015

Converting a list to a tuple makes the data immutable, which protects the data from accidental changes and can improve performance. Tuples can also be used as keys in dictionaries due to their immutability.

- 101.** Explain how the `find()` method works with an example.

**Ans :**

SQP 2019

The `find()` method searches for the first occurrence of a substring and returns its index, or -1 if not found. For example, `"Hello".find("l")` returns 2 because the first "l" is at index 2.

- 102.** What is the purpose of the `isalnum()` method?

**Ans :**

The `isalnum()` method checks whether all characters in a string are alphanumeric (letters and digits) and returns True if so. This is useful for validating user input where only letters and numbers are allowed.

- 103.** Discuss the usefulness of the `join()` method with an example.

**Ans :**

COMP 2006

The `join()` method concatenates the elements of an iterable into a single string, with the joining string as the separator. For example, `",".join(["apple", "banana", "cherry"])` produces `"apple,banana,cherry"`, which is useful for creating comma-separated values.

- 104.** What is the benefit of using string methods like `upper()` and `lower()`?

**Ans :**

MAIN 2012

These methods standardize text by converting all characters to either uppercase or lowercase, facilitating case-insensitive comparisons and ensuring consistent formatting across applications.

- 105.** How do you check if a string contains only digits?

**Ans :**

SQP 2018

You can use the `isdigit()` method, which returns True if every character in the string is a digit and False otherwise, making it ideal for validating numerical inputs.

- 106.** Explain how negative indexing works in Python strings.

**Ans :**

COMP 2011

Negative indexing starts from the end of the string, where -1 corresponds to the last character, -2 to the second-last, and so on. This method allows easy access to elements from the end without knowing the string's length.

- 107.** Describe a situation where you might use slicing with a step value.

**Ans :**

MAIN 2009

Slicing with a step value, such as `s[:2]`, is useful when you want to extract every second character from a string. This can be helpful for tasks like decoding hidden messages or sampling a subset of characters for analysis.

- 108.** What is the purpose of the `startswith()` method?

**Ans :**

SQP 2014

The `startswith()` method checks whether a string begins with a specified substring and returns True if it does, allowing you to validate the prefix of a string, such as ensuring a URL starts with `"http://"`.

- 109.** How do you remove an element from a list by its value?

**Ans :**

COMP 2007

Use the `remove()` method to delete the first occurrence of a specified value from the list. For example, `my_list.remove("apple")` removes "apple" from the list.

- 110.** What is the outcome of the expression `"data".count("a")`?

**Ans :**

MAIN 2017

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It returns 2, since the letter “a” appears twice in the string “data”.

**111.** How can you reverse a string using slicing?

**Ans :** SQP 2010

Use slicing with a negative step : `s[::-1]` returns a new string that is the reverse of `s`.

**112.** Why might you choose a tuple over a list for storing certain data?

**Ans :** COMP 2008

Tuples are immutable, making them ideal for storing data that should not change, such as configuration settings or fixed records. Their immutability also allows them to be used as keys in dictionaries.

**113.** Explain how the `index()` method works on a list.

**Ans :** MAIN 2022

The `index()` method returns the first index at which a specified element appears in a list. If the element is not found, it raises a `ValueError`, making it useful for locating elements during data processing.

## NINE MARKS QUESTION

**114.** Write a Python program that performs the following operations on a string :

1. Create a string with the value "Data Science is amazing".
2. Convert the entire string to uppercase and print the result.
3. Find and print the position of the substring "Science" within the string.
4. Replace the substring "Data" with "AI" and print the new string.
5. Check if the string starts with "AI" and print the result (True/False).
6. Count and print the number of occurrences of the letter 'a' in the string.

**Ans :** MAIN 2025

Step 1 : Create a string

`text = "Data Science is amazing"`

Step 2 : Convert to uppercase

`print(text.upper())` # Output : "DATA SCIENCE IS AMAZING"

Step 3 : Find position of "Science"

`print(text.find("Science"))` # Output : 5

Step 4 : Replace "Data" with "AI"

`new_text = text.replace("Data", "AI")`

`print(new_text)` # Output : "AI Science is amazing"

Step 5 : Check if it starts with "AI"

`print(new_text.startswith("AI"))` # Output : True

Step 6 : Count occurrences of 'a'

`print(text.count('a'))` # Output : 4`

**115.** Write a Python program that performs the following operations on a string :

1. Create a string with the value "Machine Learning makes things smart".
2. Convert the entire string to lowercase and print the result.
3. Find and print the position of the substring "makes" within the string.
4. Replace the substring "Machine" with "Deep" and print the new string.
5. Check if the string ends with "smart" and print the result (True/False).
6. Count and print the number of occurrences of the letter 'm' in the string.

**Ans :**

SQP 2021

Step 1 : Create a string

`text = "Machine Learning makes things smart"`

Step 2 : Convert to lowercase

`print(text.lower())` # Output : "machine learning makes things smart"

Step 3 : Find position of "makes"

`print(text.find("makes"))` # Output : 17

Step 4 : Replace "Machine" with "Deep"

`new_text = text.replace("Machine", "Deep")`

`print(new_text)` # Output : "Deep Learning makes things smart"

Step 5 : Check if it ends with "smart"

`print(text.endswith("smart"))` # Output : True

Step 6 : Count occurrences of 'm'

`print(text.count('m'))` # Output : 2`

**116.** Write a Python program that performs the following operations on a string :

1. Create a string with the value "Python programming is powerful".
2. Convert the entire string to uppercase and print the result.
3. Find and print the position of the substring "powerful" within the string.
4. Replace the substring "Python" with "Java" and print the new string.

```

Step 5 : Check if it starts with "Edge"
print(new_text.startswith("Edge")) # Output :
True
Step 6 : Count vowels
vowels = "aeiouAEIOU"
vowel_count = sum(1 for char in text if char in
vowels)
print(vowel_count) # Output : 13`

```

## CASE BASED QUESTION

- 123.** Case : A developer is building a contact management system that stores names and phone numbers. Explain why lists are suitable for this task and how string operations might be used.

**Ans :**

Lists are ideal because they allow dynamic modifications—contacts can be added, updated, or removed as needed. String operations such as concatenation and case conversion (using `upper()` or `lower()`) help standardize names and format phone numbers consistently for display or storage.

- 124.** Case : An e-commerce platform needs to display product descriptions stored as multiline strings. How would you create and manage these strings in Python?

**Ans :**

Use triple-quoted strings to store product descriptions, preserving line breaks and formatting. String concatenation and escape sequences can combine fixed and dynamic content. This method simplifies handling long texts and ensures that formatting remains consistent across different outputs, such as web pages or printed catalogs.

- 125.** Case : A student is analyzing a text file containing customer reviews. Describe how string slicing and the `find()` method can assist in processing the text.

**Ans :**

String slicing can extract specific portions of each review, such as the introductory sentence or summary. The `find()` method helps locate keywords or delimiters, enabling the student to isolate important sections for sentiment analysis or further textual analysis, enhancing the review processing workflow.

- 126.** Case : A programmer is developing a password validator that ensures passwords contain only alphanumeric characters. Which string methods will be useful, and how?

**Ans :**

The `isalnum()` method is essential to verify that the password contains only letters and numbers. Additionally, `len()` can be used to ensure the password meets a minimum length requirement. These methods help enforce security standards and validate input effectively.

- 127.** Case : In a data cleaning task, a researcher needs to convert all text in a dataset to lowercase for consistency. Explain the process using Python string methods.

**Ans :**

The researcher would iterate over the dataset and apply the `lower()` method to each text entry. This uniform conversion to lowercase eliminates discrepancies caused by varying cases, allowing for consistent text analysis, comparison, and subsequent processing in data analysis pipelines.

- 128.** Case : A content management system stores article titles in a list, but they must be displayed in uppercase. How can the system achieve this?

**Ans :**

The system can iterate over the list of article titles and apply the `upper()` method to each title. This conversion can be done in place or when displaying the titles, ensuring that all titles appear in a standardized, bold format on the website or print media.

- 129.** Case : An application requires that the first letter of each word in a user's input is capitalized. Explain how you might accomplish this using Python string methods.

**Ans :**

The `title()` method converts the first character of each word to uppercase and the remaining characters to lowercase. Alternatively, you can split the string into words, capitalize each word with `capitalize()`, and join them back together. This produces a neatly formatted output.

- 130.** Case : A developer wants to extract the domain from an email address stored as a string. Describe a method to achieve this using slicing and the `find()` method.

```
intelligence is evolving rapidly"
Step 3 : Extract last five characters
print(text[-5:]) # Output : "pidly"
Step 4 : Replace "Artificial Intelligence" with
"Machine Learning"
new_text = text.replace("Artificial Intelligence",
"Machine Learning")
print(new_text) # Output : "Machine Learning
is evolving rapidly"
Step 5 : Check if it ends with "rapidly"
print(text.endswith("rapidly")) # Output : True
Step 6 : Count number of words
print(len(text.split())) # Output : 6`
```

**120.** Write a Python program that performs the following operations on a string :

1. Create a string with the value "Programming in Python is fun".
2. Reverse the entire string and print the result.
3. Find and print the position of the substring "Python" within the string.
4. Replace the substring "fun" with "awesome" and print the new string.
5. Check if the string starts with "Programming" and print the result (True/False).
6. Print the number of words that start with the letter 'P' in the string.

**Ans :**

MAIN 2021

```
Step 1 : Create a string
text = "Programming in Python is fun"
Step 2 : Reverse the string
print(text[::-1]) # Output : "nuf si nohtyP ni
gnimmargorP"
Step 3 : Find position of "Python"
print(text.find("Python")) # Output : 16
Step 4 : Replace "fun" with "awesome"
new_text = text.replace("fun", "awesome")
print(new_text) # Output : "Programming in
Python is awesome"
Step 5 : Check if it starts with "Programming"
print(text.startswith("Programming")) #
Output : True
Step 6 : Count words starting with 'P'
words = text.split()
count_p = sum(1 for word in words if word.
startswith("P"))
print(count_p) # Output : 2`
```

**121.** Write a Python program that performs the following operations on a string :

1. Create a string with the value "Data Science helps in decision making".

2. Convert the entire string to uppercase and print the result.
3. Extract and print the first ten characters of the string using slicing.
4. Replace the substring "decision" with "strategic" and print the new string.
5. Check if the string contains the word "Science" and print the result (True/False).
6. Count and print the total number of spaces in the string.

**Ans :**

SQP 2016

```
Step 1 : Create a string
text = "Data Science helps in decision making"
Step 2 : Convert to uppercase
print(text.upper()) # Output : "DATA SCIENCE
HELPS IN DECISION MAKING"
Step 3 : Extract first ten characters
print(text[:10]) # Output : "Data Scien"
Step 4 : Replace "decision" with "strategic"
new_text = text.replace("decision", "strategic")
print(new_text) # Output : "Data Science helps
in strategic making"
Step 5 : Check if it contains "Science"
print("Science" in text) # Output : True
Step 6 : Count spaces in the string
print(text.count(" ")) # Output : 5`
```

**122.** Write a Python program that performs the following operations on a string :

1. Create a string with the value "Cloud Computing makes storage easier".
2. Convert only the first letter of each word to uppercase and print the result.
3. Find and print the position of the substring "storage" within the string.
4. Replace the substring "Cloud" with "Edge" and print the new string.
5. Check if the string starts with "Edge" and print the result (True/False).
6. Print the number of vowels in the string.

**Ans :**

COMP 2012

```
Step 1 : Create a string
text = "Cloud Computing makes storage easier"
Step 2 : Convert to title case
print(text.title()) # Output : "Cloud Computing
Makes Storage Easier"
Step 3 : Find position of "storage"
print(text.find("storage")) # Output : 22
Step 4 : Replace "Cloud" with "Edge"
new_text = text.replace("Cloud", "Edge")
print(new_text) # Output : "Edge Computing
makes storage easier"
```

5. Check if the string starts with "Java" and print the result (True/False).
6. Count and print the number of occurrences of the letter 'p' in the string.

Ans :

COMP 2013

Step 1 : Create a string

text = "Python programming is powerful"

Step 2 : Convert to uppercase

print(text.upper()) # Output : "PYTHON PROGRAMMING IS POWERFUL"

Step 3 : Find position of "powerful"

print(text.find("powerful")) # Output : 22

Step 4 : Replace "Python" with "Java"

new\_text = text.replace("Python", "Java")

print(new\_text) # Output : "Java programming is powerful"

Step 5 : Check if it starts with "Java"

print(new\_text.startswith("Java")) # Output : True

Step 6 : Count occurrences of 'p'

print(text.count('p')) # Output : 2`

117. Write a Python program that performs the following operations on a string :
  1. Create a string with the value "Cloud computing is the future".
  2. Convert the entire string to lowercase and print the result.
  3. Find and print the position of the substring "future" within the string.
  4. Replace the substring "Cloud" with "Edge" and print the new string.
  5. Check if the string ends with "future" and print the result (True/False).
  6. Count and print the number of occurrences of the letter 'c' in the string.

Ans :

MAIN 2006

Step 1 : Create a string

text = "Cloud computing is the future"

Step 2 : Convert to lowercase

print(text.lower()) # Output : "cloud computing is the future"

Step 3 : Find position of "future"

print(text.find("future")) # Output : 23

Step 4 : Replace "Cloud" with "Edge"

new\_text = text.replace("Cloud", "Edge")

print(new\_text) # Output : "Edge computing is the future"

Step 5 : Check if it ends with "future"

print(text.endswith("future")) # Output : True

Step 6 : Count occurrences of 'c'

print(text.count('c')) # Output : 2`

118. Write a Python program that performs the following operations on a string :

1. Create a string with the value "Technology shapes the world".
2. Convert the entire string to title case and print the result.
3. Find and print the position of the substring "world" within the string.
4. Replace the substring "Technology" with "Innovation" and print the new string.
5. Check if the string contains the word "shapes" and print the result (True/False).
6. Count and print the number of occurrences of the letter 'o' in the string.

Ans :

SQP 2009

Step 1 : Create a string

text = "Technology shapes the world"

Step 2 : Convert to title case

print(text.title()) # Output : "Technology Shapes The World"

Step 3 : Find position of "world"

print(text.find("world")) # Output : 20

Step 4 : Replace "Technology" with "Innovation"

new\_text = text.replace("Technology", "Innovation")

print(new\_text) # Output : "Innovation shapes the world"

Step 5 : Check if it contains "shapes"

print("shapes" in text) # Output : True

Step 6 : Count occurrences of 'o'

print(text.count('o')) # Output : 3`

119. Write a Python program that performs the following operations on a string :

1. Create a string with the value "Artificial Intelligence is evolving rapidly".
2. Convert the entire string to lowercase and print the result.
3. Extract and print the last five characters of the string using slicing.
4. Replace the substring "Artificial Intelligence" with "Machine Learning" and print the new string.
5. Check if the string ends with "rapidly" and print the result (True/False).
6. Count and print the number of words in the string.

Ans :

COMP 2010

Step 1 : Create a string

text = "Artificial Intelligence is evolving rapidly"

Step 2 : Convert to lowercase

print(text.lower()) # Output : "artificial

Ans :

First, use `find("@")` to locate the index of the "@" symbol in the email. Then, slice the string from one index past "@" to the end to extract the domain. This method reliably isolates the domain for further processing or display.

- 131.** Case : A web application needs to join a list of URL parts into a complete URL. Explain how the `join()` method can be utilized.

Ans :

The `join()` method can combine a list of URL segments into a single URL string using a separator, such as `"/"`. For example, `"/".join(["https:", "example.com", "page"])` produces a properly formatted URL. This method ensures consistency and reduces manual string concatenation errors.

- 132.** Case : A robotic application stores sensor readings as strings and needs to verify that each reading contains only digits. How can this be achieved?

Ans :

By using the `isdigit()` method on each sensor reading string, the program can confirm that the string contains only numeric characters. This validation ensures that the sensor data is correctly formatted for conversion to numerical values and subsequent analysis.

Below are 10 application-based questions with answers, each answer extended by one additional explanatory line :

- 133.** A developer is building a registration form and wants to ensure that usernames contain only letters. Which string method should be used to validate the name, and how would you implement it in Python?

Ans :

They should use the `isalpha()` method to verify that all characters in the username are alphabetic.

```
username = "JohnDoe"
if username.isalpha() :
 print("Valid username")
else :
 print("Username must contain only letters.")
```

This ensures that usernames do not include numbers or special characters, maintaining data integrity.

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- 134.** A program needs to count how many times the word "error" appears in a log file string. Which string function would be best, and how would you use it in Python?

Ans :

They should use the `count()` method to tally the occurrences of "error".

```
log = "error : file not found. error : connection
timed out. error : invalid input."
```

```
error_count = log.count("error")
```

```
print("Number of errors :", error_count)
```

This method quickly quantifies specific keywords in logs, aiding in debugging and monitoring processes.

- 135.** An email processing application needs to extract the domain from an email address. Which string operations are useful for this task, and how would you implement them?

Ans :

They can use the `find()` method to locate the "@" symbol and then slice the string from that point onward.

```
email = "user@example.com"
```

```
at_index = email.find("@")
```

```
domain = email[at_index+1:]
```

```
print("Domain :", domain)
```

This approach efficiently isolates the domain by slicing the string right after the "@" character.

- 136.** A messaging app requires building a welcome message by combining a greeting with the user's name. How can string concatenation be utilized here, and what should be considered due to string immutability?

Ans :

They can use the `+` operator to concatenate the greeting, username, and punctuation into a new string.

```
greeting = "Welcome, "
```

```
name = "Alice"
```

```
welcome_message = greeting + name + "!"
```

```
print(welcome_message)
```

Because strings are immutable, this concatenation creates a new string without altering the original values.

- 137.** A report generator needs to output a multi-line message with proper formatting, including line breaks and indentation. Which string feature supports this, and how can it be implemented in Python?

Ans :

They should use escape sequences like ``\r`` for newlines and ``\t`` for tabs to format the string.  
`report = "Report :\r\t- Item A\r\t- Item B\r\t- Item C"`

`print(report)`

Escape sequences allow for clear formatting within a single string, making the output more readable.

- 138.** A program requires displaying each character of a given string on a new line. Which method can be used to iterate through the string, and how would you implement it in Python?

Ans :

They can loop through the string with a ``for`` loop, printing each character individually.

`message = "Hello"`

`for char in message :`

`print(char)`

This character-by-character iteration is useful for processing or analyzing each element of the string separately.

- 139.** An application wants to generate a repeated laugh effect by replicating the substring "ha" multiple times. Which operator is used for this repetition, and how is it implemented?

Ans :

They should use the `` ``` operator to repeat the string a specified number of times.

`laugh = "ha" 3`

`print(laugh) # Output : hahaha`

Using the repetition operator simplifies the creation of repeated patterns without requiring explicit loops.

- 140.** To perform case-insensitive comparisons in a search function, how can a string be standardized, and which methods support this in Python?

Ans :

They can use the ``lower()`` or ``upper()`` methods to convert the string to a uniform case.

`text = "Python Programming"`

`if text.lower().startswith("python") :`

`print("Match found")`

Standardizing the case ensures that comparisons are not affected by variations in capitalization.

- 141.** A date needs to be formatted by joining individual components (year, month, day) with hyphens. Which string method is best for this, and how would you implement it in Python?

Ans :

They should use the ``join()`` method to combine the list of date components with a hyphen as a separator.

`date_components = ["2025", "02", "12"]`

`formatted_date = "-".join(date_components)`

`print("Formatted Date :", formatted_date)`

The ``join()`` method efficiently creates a single formatted string from a list of elements with the specified separator.

- 142.** A text editor feature must replace all occurrences of the word "sample" with "example" in a document. Which string function is ideal for this, and how would you use it in Python?

Ans :

They should use the ``replace()`` method to substitute every occurrence of "sample" with "example".

`text = "This is a sample text with sample words."`

`new_text = text.replace("sample", "example")`

`print(new_text)`

Output:

This is a example text with multiple example words.

Explanation:

1. The `.replace("old", "new")` method replaces all occurrences of "sample" with "example".
2. It works on strings and does not modify the original string (strings are immutable in Python).
3. If you need to replace only a limited number of occurrences, you can pass a third argument: `.replace("sample", "example", count)`, where count is the number of replacements.

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